Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Computer Science 14 (2012) 148 – 154

Procedia Computer Science

Proceedings of the 4th International Conference on Software Development for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2012)

A tool to evaluate the level of inclusion of digital learning objects

Mariluz Guenaga[a]*, Iratxe Mechaca[a], Susana Romero[a], Andoni Eguíluz[a]

[a]DeustoTech Learning, Deusto Foundation-University of Deusto, Avda. Universidades 24, 48007 Bilbao, Spain

Abstract

Inclusive learning integrates pedagogical and technological variables. It means to adapt to students according to their characteristics (personal, physical, cognitive, social…), needs and interests. With the aim of evaluating the level of inclusion of digital learning objects we have developed a questionnaire that collects information about pedagogical and technological aspects that promote or discourage inclusion. Features like the pedagogical model, function of activities, type of assessment, multimedia resources, human-computer interaction, accessibility and usability criteria, etc. are variables that impact in the level of inclusion of educational objects and items that have been included in the questionnaire. This is the second version of the tool, refined with the conclusions obtained from the application of the draft version to more than 50 learning objects developed under the funding and supervision of the Basque Government. These objects are available under Creative Commons license in the Agrega web page of the Education Department, and represent the style and characteristics of more than 350 objects.

Keywords: learning object; inclusion; evaluation; pedagogical model; accessibility; usability;

1. Introduction

DeustoTech Learning unit is a research group that belongs to Deusto Foundation / University of Deusto. One of our research interests is the design of educational content using innovative technology, or in other words: the design of technology enhanced educational content. With this purpose we applied to a call published by the Basque Government in 2010 to create Digital Educational Objects (DEO) [1] . This call is within a program called Escuela 2.0 [2] from de Spanish Ministry of Education aimed to integrate technology in the

* Tel.: +34-944-139-000; fax: +34-944-139-101.
E-mail address: mlguenaga@deusto.es

 doi:10.1016/j.procs.2012.10.017

classroom.

The objective of our project was to create eight didactic sequences to be used in Technology subject in the first year of secondary school. The call described a didactic sequence as [1] «*the structure is composed, mainly, of a set of digital objects of level 2 (learning object), and exceptionally of level 1 (basic object). From the functional point of view it includes learning/assessment activities implicit in objects of level 2, as well as conceptual maps. Optionally, it could include a navigation map of those objects of level 2. The average curriculum coverage is a subarea of knowledge of a given course of cycle*». The average duration of each educational sequence is of three hours in the classroom. The work was done under these and other conditions established by the call.

Once we finished our work we analyzed content created by other authors, available under Creative Commons license at Agrega web site of the Basque Government (http://agrega.hezkuntza.net). The first conclusion is that the lack of design guideline caused a wide variety of objects, their pedagogical approach, interface design, technology used, extension, etc.

Our concern with quality evaluation and accessibility made us look for the level of inclusion of uploaded learning objects. This led us to initiate a project to evaluate the level of inclusion of digital objects funded by the Basque Government under calls of years 2009 and 2010. This project made us reflex about how to evaluate the level of inclusion of digital educational content. This article describes the results of our work and provides tools to evaluate how digital educational objects promote inclusive learning.

2. Inclusive learning objects

There is a discussion <round digital learning objects between authors that support a more technological approach, they define learning objects as educational resources that comply standards, classified by a set of metadata, and designed to be used in different educational contexts [3] [4]. On the other hand there are authors that define learning objects as interactive tools that aim to support learning and favor students' cognitive process [5] [6].

The term Digital Educational Object refers to digital and interactive educational content structured in didactic sequences that has been designed with a pedagogical objective, and can be used in different educational contexts. In this definition we highlight two characteristics: *reusability* - digital objects designed to be used freely in different contexts; and *granularity* - an object consists of several educational elements that have, by themselves, an educational purpose and can be used in different contexts [7] [8] [9] [10].

Learning Objects should follow international standards like LOM (Learning Object Metadata) and SCORM (Shareable Content Object Reference Model) to provide metadata that describe the content and enables the development of advanced services and tools [11] [12].

When we talk about inclusion the first thought is accessibility: how to make content and interaction accessible for users with different functionality. However inclusion is not only a matter of technology and human-computer interaction, but it means to adapt to students' characteristics like the learning pace, personal aptitudes, technological skills, attention to diversity, etc. Inclusive education has to integrate students, attend their singularity and adapt to specific contexts.

In order to evaluate the level of inclusion of learning objects we have to focus on pedagogical and technological variables. Later we will describe in detail the questionnaire we have developed to gather information about inclusion, but briefly we can say it includes questions related to *pedagogy*: assessment activities, the purpose of multimedia resources or the type of activities proposed to students; and related to *technology*: the existence of alternative media to transmit a content, keyboard access, coherent and clear navigation schema, etc.

3. Review of pedagogical and technological principles

3.1. Pedagogical models

When we designed the first version of our questionnaire, November 2011, we carried out a review of educational paradigms through history in order to define educational trends and identify underlying pedagogical model of analyzed digital objects. Pedagogical model determines a set of features like graphical design, structure and logical sequence, form of interaction, methodologies, etc. and that is why we thought it was necessary to evaluate this point and include it in our evaluation tool.

At the end of the survey carried out with the first version of the questionnaire we identified three pedagogical models: cognitive, constructivist and social. In order to evaluate the pedagogical model we focused on objectives, methodology and assessment of different learning objects. The results of the first survey concluded that general trend was a constructivist and social pedagogical model. This analysis corresponds to prevailing educational trend in our learning processes and systems, which promote learning systems centered in students and their learning process, experimentation, knowledge construction, problem solving and collaboration [13] [8].

The social constructivist educational paradigm is in line with inclusive learning. A way to answer current social demand is to propose initiatives oriented to collaborative work to achieve more inclusive learning environments. These educational principles are a heritage from the social educational model boosted by Vygotsky, who highlighted the importance of social relations in the cognitive and personal development of individuals [14].

3.2. Technological inclusion: accessibility and usability

Specific studies on standards for developing educational objects have focused on accessibility and usability [19]. Regarding accessibility they recommend Web Content Accessibility Guidelines 2.0-WCAG. For usability, they refer to ISO 9126- Software Product Quality, but it was replaced by ISO/IEC 25000:2005 SQuaRE- Software Product Quality Requirements and Evaluation.

In order to create technological accessibility indicators we relied on the UNE 139803:2004 rule [20], the Spanish guide to Web accessibility, ISO 24751 «Individualized adaptability and accessibility in e-learning, education and training» and in WCAG 2.0, the recognized standard on Web accessibility at a European level. Even WCAG 2.0 were designed specifically for web content, the fact is that they can be used to evaluate online and offline content. At a first stage, seeing the overall design of learning objects uploaded to the Basque site of Agrega, we consider enough to check the less restrictive level of conformance (A) to evaluate the accessibility of learning objects.

If we analyze digital resources in detail we find it necessary to apply other guidelines and standards. This is the case of multimedia resources like video or audio that should have alternatives like subtitles. AENOR-UNE 153010 «Captioning for deaf and hearing impaired. Via teletext subtitling» is a Spanish rule to create subtitles for hearing impaired people. The fact is that we have not found video or audio with subtitles for the hearing impaired so there has not been the opportunity to evaluate their adequacy to the rule.

4. The tool: a questionnaire to evaluate the level of inclusion of learning objects

In October 2011 we began to design a questionnaire that could be used to evaluate the level of inclusion of digital educational objects developed under the support of the Basque Government. It was applied to more than 57 digital educational objects that represented the style of more than 350 learning objects in Agrega. The

conclusions we obtained from this survey were the basis to redesign the questionnaire and refine the questions to have more and better results of the learning objects.

Previous research on the evaluation of learning objects centered in the design, implementation and students' needs [15], while others focused in the analysis of the instructional process and the impact of learning objects [16]. Some authors, closer to our analysis approach, consider evaluation around a set of quality indicators of educational multimedia objects, such as the coherence with the learning objectives, quality of the content, feedback, adaptation, motivation, design, presentation, usability, interaction, accessibility, reusability and compliance with standards [17] [18] [3].

4.1. The tool, a questionnaire

As we have mentioned before the evaluation of the level of inclusion of learning objects have two approaches: pedagogical and technical. The questionnaire reflects these facets through specific questions; however some characteristics of the objects impact in both aspects.

4.1.1. Questions related to the pedagogical aspect of the learning object

- The margin for initiative of the student indicates if the navigation is guided, the user has to follow strictly the navigation path, or exploratory, students are able to explore and access information according to their interests.
- Interaction level can be low, students only can go forward and backward and select objects; medium, they have freedom to select the content, sequence and time they dedicate to each section; or high, content accessible through multiple path and different point of views.
- The number of people implied in activities is relevant. It can be single use, small groups (two to seven) or medium/large groups (eight to 20).
- In learning objects we check if the type of answer given in activities is closed, open or multiple choice.
- The function of activities is also meaningful. It can be a reinforcement activity, recreational, information processing, assessment, development of critical thinking (opinion, discussion…) or application of concepts and skills development.
- Regarding attention to diversity we focus on the existence of levels of difficulty, the possibility to abandon at any time, if it is possible to save results and recover initiated activities, help and instructions available and description of errors to students.
- It is necessary to analyze each multimedia resource in the learning object. From the pedagogical point of view we are interested in their function that can be informative, demonstrative, motivating, represents reality or instructional.

The study of this set of variables leads us to define the level of inclusion of digital learning objects. The interactivity level and the scope for initiative of the student let us know the level of freedom that allows students direct their own learning according to their interests, needs and learning pace. This is also related to attention to diversity. As long as educational resources provide help to students, for example the possibility to repeat activities, save results or identify errors and learn from them, we will contribute them to be more autonomous and they will be able to learn and solve problems by themselves. The higher the number of possibilities to direct and to be the main character of their learning, the better we will adapt to principles for inclusion.

The methodologies proposed related to grouping of students and the type of answer will enable different levels of inclusion. In general we can say collaborative activities, discovery learning and the construction of self-knowledge promote learning.

Finally, related with the variety of multimedia resources, inclusive learning trends neither promote concrete resources nor exclude others, the objective should be to favor the existence of varied complementary multimedia resources, integrated, and oriented to a learning objective [14].

4.1.2. Questions related to the technological aspect of the learning object

Technological variables involved in the questionnaire are closely related to accessibility and usability guidelines analyzed before. We have tried to simplify the evaluation with questions that integrate different elements that measure the level of inclusion of learning objects.

- We have to analyze if multimedia content has playback controls, textual alternative or other alternatives like subtitles, audio description, dubbing or sign language.
- Playback controls enable users to pause, stop and review/listen again multimedia resources as many times as needed, what directly means an adaptation to the user.
- Alternative media to access a resource is needed to complement information and make it more understandable (e.g. a video with subtitles may reinforce the information comprised in it) and promotes accessibility for people with functional diversity (e.g. deaf people can access a video if it has subtitles or sign language; subtitles may help to understand an audio in a noisy place).
- The user interface is adaptable if it provides functions to change the look and feel (font size, color, style, background color…). Content should be customizable to fit different screen size depending on the device, adjust colors and contrast to lighting conditions or visual impairment.
- Elements and functions should be available using only the keyboard. That is how assistive technologies (Braille display, alternative keyboards, haptic devices, etc) or alternative input devices could control and interact with the interface.
- There should not be unnecessary blinking elements, they do not have a pedagogical function and disturb the reading and comprehension of educational content. In case blinking is needed the frequency, color and contrast should be carefully chosen to achieve a good level of understanding.
- Navigation schema is consistent and intuitive so students needs few time to get familiar to the interface, all the time they know where they are and where they can go, and need no further help to move through the learning object.
- The language used is clear, comprehensive and adequate to the target audience. It should adapt to the age and knowledge of students. Complementary media and activities to transmit an idea helps students to understand it (e.g. text + video + simulation).
- Writing predictors and orthography correctors increase the success of data input to learning objects. We should check if the interface facilitates this kind of functionality.
- Links to external resources enrich the educational content but make the author loose the control over the level of inclusion. If there is a high number of links to third party web pages and tools the risk of not taking inclusion into account is higher.
- Content, activities or functions created with other tools like JClic, Hotpotatoes, Flash, or even pdf, rtf files should be checked in order to evaluate their level of inclusion. In this first approach we have focus on the existence and overall characteristics of these resources.

The conjunction of some of the questions above and other variables give us a measure of the complexity of the learning object. The number and type of activities (interactive, simulations,…), the amount of content units, the number, type and function of multimedia resources or the level of interaction between the student and the learning object determines the complexity of the object. This is not directly related to the level of inclusion, on one hand more complex objects are supposed to be more difficult to be inclusive, on the other hand complex

objects are richer in possibilities for students, type of activities, external and multimedia resources, and so, they could adapt better to students' characteristics. This is something that needs further research and we will analyze it applying our tool to multiple and varied learning objects.

5. Next steps

The next step of our research consists on experimentation in schools in order to evaluate the tool we have created. We will select five educational objects from the Agrega catalogue and will invite five to ten schools from the Basque Country to use them in class. In this way we can proof the educational content in a real environment and see if the teacher experience and feedback meets the results of the evaluation using our questionnaire. After several working session with the educational content we will have an interview with the teacher and focus group with some of them, so we can review the items in the questionnaire, and see if it really includes the questions that measures the level of inclusion of the learning object (technological and pedagogical variables).

This evaluation phase will help us to verify how the tool meets the objective of evaluating the level of inclusion of educational objects, and to analyze which characteristics have a greater difference between tool-evaluation and in-class teacher evaluation.

6. Conclusions and future work

Learning objects' inclusion is not only a matter of technological accessibility. There are other variables that have to be taken into account to measure how learning objects adapt to specific characteristics of students. The evaluation of inclusion covers pedagogical and technological aspects that impact in the learning process, which can be personalized thanks to the pedagogical model that underlies learning objects and also using adequate technology to develop them.

We have presented tool, formed of a set of questions, which collects information about what learning objects do to promote inclusion. A questionnaire that gives us a measure of the basic characteristics related with the pedagogical model, accessibility and usability. A first version of the questionnaire was proved with learning objects developed under a call of the Basque Government. The conclusions of the survey and the results obtained made us modify the tool and refine some aspects.

In the next weeks we are going to use the questionnaire to evaluate the level of inclusion of digital learning objects uploaded to the national Agrega portal, under the Ministry of Education. The higher variety of producers, and therefore styles, will serve us to see if the questionnaire is valid to all kind of learning objects or, on the contrary, there are aspects not covered with developed questionnaire. At the same time we will carry out a survey about the level of inclusion of learning objects developed at national level.

References

[1] BOPV - Boletín Oficial del País Vasco nº 128, martes 6-jul-2010. ORDEN de 15 de junio de 2010, de la Consejera de Educación, Universidades e Investigación, por la que se convocan ayudas para la elaboración de Objetos Digitales Educativos (ODEs) en la Comunidad Autónoma Vasca. (2010)

[2] Moncloa - Council of Ministers 2009-07-31. La Moncloa. http://www.lamoncloa.gob.es. (2009)

[3]Parrish, P. E. The trouble with learning objects, Educational Technology Research & Development, 52(1), 49–67. (2004)

[4] Wiley, D., Wayers, S., Dawson, D., Lambert, B., Barclay, M. & Wade, D. Overcoming the limitations of learning objects, Journal of Educational Multimedia and Hypermedia, 13(4), 507–521. (2004)

[5] Bradley, C. & Boyle, T. The design, development, and use of multimedia learning objects, Journal of Educational Multimedia and Hypermedia, 13(4), 371–389. (2004)

[6] Kay, R. H. & Knaack, L. Assessing learning, quality and engagement in learning objects: the Learning Object Evaluation Scale for Students (LOES-S), Educational Technology Research and Development Volume 57, Number 2, 147-168 (2008)
[7] Cuadrillero Menéndez, J. A., Serna Nocedal, A. and Corrochano, J. H. Estudio sobre la granularidad de objetos de aprendizaje almacenados en repositorios de libre acceso. IV Simposio Pluridisciplinar sobre Diseño, Evaluación y Desarrollo de Contenidos Educativos Reutilizables. (2007)
[8] Churchill, D. Towards a useful classification of learning objects. Educational Technology Research and Development, Volume 55, Number 5, 479-497 (2007)
[9] IEEE LTSC. Draft Standard for Learning Object Metadata, April 2001. Available at http://ltsc.ieee.org/wg12/index.html (2001)
[10] Wiley, D. The Instructional Use of Learning Objects. Agency for Instructional Technology and the Association for Educational Communications and Technology. Available at http://reusability.org/read (2000)
[11] Bohl, O.; Scheuhase, J.; Sengler, R.; Winand, U.; Kassel Univ., Germany. The sharable content object reference model (SCORM) - a critical review. ICCE '02 Proceedings of the International Conference on Computers in Education, (2002)
[12] Kavcic, A. Implementing content packaging standards. EUROCON - International Conference on Computer as a Tool (EUROCON), IEEE (2011)
[13] Friesen, N. Three Objections to Learning Objects. Retrieved July 24, 2004 from http://www.learningspaces.org/n/papers/objections.html (2003)
[14] César M. & Santos, N. From exclusion to inclusion: Collaborative work contributions to more inclusive learning settings. European Journal of Psychology of Education Volume 21, Number 3, 333-346. (2006)
[15] Williams, D. D. Evaluation of learning objects and instruction using learning objects. In D. A. Wiley (Ed.), The instructional use of learning objects (chap. 3.2, pp. 1-32). (2000)
[16] Kay, R. H. & Knaack, L. Evaluating the learning in learning objects, Open Learning Vol. 22, No. 1, February 2007, pp. 5–28. (2007)
[17] Leacock, T. L., & Nesbit, J. C. A Framework for Evaluating the Quality of Multimedia Learning Resources. Educational Technology & Society, 10 (2), 44-59. (2007)
[18] Hamel, C. J. & Ryan-Jones, D. Designing instruction with learning objects. International Journal of Educational Technology, 3(1). (2002)
[19] Centro Nacional de Investigación y Comunicación Educativa-CNICE. Accesibilidad, TIC y Educación. Serie Informes-17. Consultado el 20 de diciembre en http://ares.cnice.mec.es/informes/17. (2006)
[20] AENOR-Asociación Española de Normalización y Certificación, AENOR. UNE 139802:2003 Requisitos de accesibilidad al ordenador. Software. (2003)