# Delivery of accessible and SCORM-based courses in dotLRN

Olga C. Santos[1], Carmen Barrera[1], Emmanuelle Gutiérrez y Restrepo[2], Jorge Granado[1], Ludivine Martin[1], Emmanuelle Raffenne[1], Alejandro Rodriguez[1] and Jesús G. Boticario[1].

[1] aDeNu Research Group, Artificial Intelligence Department, Computer Science School, UNED, C/Juan del Rosal, 16. 28040 Madrid, Spain
{ocsantos, jgb}@dia.uned.es
http://adenu.ia.uned.es/

[2] SIDAR Foundation-Universal Access.
C/ Sancho Dávila, 35, 28028 Madrid, Spain
emmanuelle@sidar.org
http://www.sidar.org

**Abstract.** In the paper we present the methodology used in order to produce accessible and SCORM-compliant courses starting with conceptual design and to deliver them as instructional package in dotLRN accessible platform. This is part of the ALPE project, Accessible Learning Platform for Europe (EC-029328).

**Keywords:** disabled students, accessibility, SCORM, basic skills, market validation, educational standards, e-learning platform, LMS, dotLRN

## 1. ALPE project

The ALPE project - Accessible e-Learning Platform for Europe (EC-029328) - is a market validation project partially funded by the European Commission through the eTEN program, “Deploying Trans-European e-Services for all”. The ALPE project targets European disabled adult citizens who want to improve their basic skills, and hence their employability levels through an accessible e-learning platform.

For this purpose, the ALPE project has set up an open-source, standard-based and accessible e-learning platform. This platform uses dotLRN, the most widely adopted enterprise-class open source software for supporting e-learning and digital communities.

This platform delivers courses from a repository of accessible, multilingual, SCORM (Shareable Content Object Reference Model) -compliant courses on basic skills, which draws on the practical lessons learned on pedagogical and organisational issues relating to accessible e-learning. Basic skills are defined as “the ability to read, write and speak in the respective language and to use mathematics at a level necessary to function at work and in society in general”. This concurs with the Lisbon

Memorandum of Understanding (23-24 March 2000) and the Uppsala Swedish Presidency (2002) which reinforced the requirement for training in basic skills such as reading, writing, and arithmetic, lifelong learning, IT proficiency and the fundamental knowledge needed for everyday life.

ALPE offers a web portal to end-users through which they will be able to search and select the most appropriate basic skill courses for their needs, most of the time with the support of their tutors or mentors. Currently no service exists to support disabled and adult learners in improving basic skills through a repository of accessible, reusable courses. In this paper will detail the methodology to produce accessible and standard-based contents. Standards offer the maximum integration between different technologies, facilitating accessibility and reusability.

### 1.1. ALPE Platform

The ALPE service is provided upon an existing open source learning management system (LMS) called dotLRN [1]. It provides a complete portal framework along with out-of-the-box capabilities for course management, online community tools, content management for publishing in academic settings, and learning management tools for administering tests and tracking results. It features a number of collaborative applications such as calendars, forums, file sharing, assessment tools, etc. Many of these functionalities are similar to the ones found in other LMS such as WebCT and Blackboard, but it provides additional features made possible by the common data model (e.g. a centralised alert system) and others related to the management of collaborative activities, not just courses. The great advantage is that dotLRN is structurally flexible and accessible and supports tools and contents based on interoperable standards. Specifically, the following functionalities are available for learners with special needs:

- Access to interactive and accessible basic skills courses (SCORM compliant)
- Assessment of the progress in the basic skills addressed in the course using accessible questionnaires defined in the IMS-QTI (Information Management System Question and Test Interoperability) educational standard
- Grouping users to solve collaboratively a learning activity using accessible collaborative components, such as forums, file storage, comments, etc.
- Scheduling of basic skills course activities through an accessible interface
- Language selection functionality, supporting assistive technology available on the client workstation.
- Adapted interface configurations for each learner according to the learners' user model, accessibility requirements and basic skills learning objects.
- Private spaces and information fully accessible through secure interfaces, using secure authentication mechanisms

In summary, the variety of tools provided by the platform support a wide range of interaction situations for users who have different needs.

### 1.2. ALPE courses

ALPE course repository provides a set of web-based, SCORM-compliant and accessible courses, all with interoperability features. The repository covers basic skills on literacy, numeracy ("numerical literacy") and ICT (Information and Communications Technologies). The courses have been customised from existing courses developed in the institutions involved in the project, as well as selected from open repositories. These courses are prepared to suit the pedagogical and technical needs for different types of disabilities, and the localization, linguistic and cultural requirements for the three countries involved in the project. Below we detail the methodology to create those courses.

## 2. Accessible content

Next we introduce the guidelines, tools and standards to create accessible contents, and the validation steps.

### 2.1 Create accessible content - Guidelines

The Web Accessibility Initiative (WAI) develops guidelines widely regarded as the international standard for Web accessibility: Web Content Accessibility Guidelines of (WCAG) [2]. WAI has defined accessibility checklists to validate the accessibility of the developed contents. The content's compliance with all the checkpoints ensure that the content will be read and rendered properly through various technical aids, such as Braille transcriptors, screen amplifiers, screen readers, etc.

Also, an appropriate course design will greatly improve the course quality in general as well as its accessibility. For example, an accessible course will be easier to follow, even if the environment is not ideal: environment with lots of noise, browser with missing plug-in or not properly configured, slow connection, problem with downloading. Compliance with accessibility guidelines results in offering alternatives in the way information is received.

At the stage of creating content, it is worth respecting some guidelines, based on WCAG aimed to non-technical course' authors. It is much more efficient to take into account accessibility at the course' design stage, than to try to make accessible a course that is already existing.

The guidelines for textual contents are:

1. Structure the contents
    a) make the structure clear and obvious
    b) use a clear language with direct sentences
    c) divide blocks of information into paragraphs with one key idea per paragraph
    d) use headers to properly identify contents
    e) introduce the key idea at the beginning of the paragraph, list, etc.

f) use bullet list for affirmation
g) begin links and headers with relevant and specific words
h) avoid putting relevant content at the bottom of the page
i) use anchors to refer to content within the same page

2. Terminology
   a) think of how the important words would be pronounced by a screen reader and write them appropriately
   b) use standard naming conventions
   c) make sure to write explicitly the keywords students will be searching for
   d) avoid text on images
   e) be consistent with the vocabulary used within the text, the descriptions and the content that is not textual
   f) check the spelling
3. Extra information on content
   a) include an exact description for each image
   b) If the image is purely decorative, leave the “alt” tag and “longdesc” tag empty
   c) add useful descriptions for links
   d) identify when abbreviations or acronyms are used
   e) identify headers

Those guidelines focus on text content accessibility and should be followed to generate accessible content.. Their compliance is necessary but not sufficient to ensure the course accessibility.,

The following checklist applies to the Web and summarizes key-concepts of accessibility [3]

1. Images & animations: Use the alt attribute to describe the function of each visual.
2. Image maps. Use the client-side map and text for hotspots.
3. Multimedia. Provide captioning and transcripts of audio, and descriptions of video.
4. Hypertext links. Use text that makes sense when read out of context. For example, avoid "click here."
5. Page organization. Use headings, lists, and consistent structure. Use CSS for layout and style where possible.
6. Graphs & charts. Summarize or use the longdesc attribute.
7. Scripts, applets, & plug-ins. Provide alternative content in case active features are inaccessible or unsupported.
8. Frames. Use the noframes element and meaningful titles.
9. Tables. Make line-by-line reading sensible. Summarize.
10. Check your work. Validate. Use tools, checklist, and WCAG guidelines

### 2.2. Create accessible content : tools and standards

a) For Word processing: CourseGenie

The situation encountered is that university professors usually prepare their courses using Microsoft Office Word. Since ideally the theme of accessibility should be addressed as soon as possible in the process of creating course, we looked for a solution to convert existing Microsoft Office Word documents into an accessible output. CourseGenie was chosen according to the results of a state-of-the-art study done on editors supporting accessible and educational standard-based courses [4]. CourseGenie is a plug-in for Word and offers several advantages:

- it provides different predefined styles to appropriately and consistently format the different text elements.
- it allows including in the course QTI Lite assessments (see below) and metadata information
- it provides automatic validation tests on very commonly used elements, such as images (alt and long description) and tables (row and column headers).
- lastly and foremost, it generates SCORM packages containing the corresponding XML manifest with course items and related resources such as the contents of the Word document separated into accessible HTML pages.

In ALPE, CourseGenie has been used to create accessible HTML pages, which are then packaged into SCORM. During the process, some problems related with the validation of the HTML code generated by CourseGenie have been encountered.

b) For multimedia: SMIL

One of the biggest challenges in multimedia accessibility is to provide alternative form of content. SMIL (Synchronized Multimedia Integration Language) addresses this issue. It is a W3C (World Wide Web Consortium) recommended XML mark-up language for describing multimedia presentations. It defines mark-up for timing, layout, animations, visual transitions, and media embedding, among other things.

A SMIL document is similar in structure to an HTML document.

SMIL allows an author to synchronize various media-specific presentation tracks (such as text captions, audio descriptions, subtitles, parallel video tracks of signed interpreters, simplified versions of presentation elements) and various test attributes allow the user to select the track they need

An important factor in accessibility is user control – the ability to zoom in on an image, change a font, etc. The SMIL specification includes some requirements for players (User Agents) to allow the necessary level of control. For example the systems captions attribute in the current generation of SMIL players allows the user to specify which captions should be rendered.

The accessibility benefits of style sheets are well established. SMIL uses CSS (Cascading Style Sheets) to control many aspects of the presentation and layout, which allows the user to change the presentation according to their needs.

c) For mathematical notation: MathML

MathML (Mathematical Mark-up Language) is an application of XML for describing mathematical notation and capturing both its structure and content. It aims at integrating mathematical formulae into Web documents. It is a recommendation of the W3C math working group.

Prior to the development of MathML, a common approach to present mathematical notation using a web browser was to use static images such as GIFs or JPGs, which was not ideal from an accessibility standpoint.

Since MathML is written using XML this enables mathematical expressions to be held and used within other XML documents. MathML can be stored within and presented to the user using XHTML documents.

Although MathML supports varies between Internet browsers, MathML is the most widely understood and adopted mathematical mark-up language and offers both users and developers a standards-based approach to efficiently present mathematics to end users.

d) For assessments: QTI

QTI (Question and Test Interoperability) is a specification from the IMS group to allow electronic assessments to be exchanged between different Managed Learning Environment (MLE) and Virtual Learning Environment (VLE) systems. A learning environment, MLE or VLE will recognise a QTI learning resource and interpret the data it holds to enable a user to participate in an online assessment. Then, the learning environment may collect the results and present them to a tutor, allowing progress to be reviewed.

The QTI specification describes an extensible mark-up language (XML) structure. It does not explicitly address the issue of accessibility. Instead assessment accessibility depends on how the QTI XML data is presented to the user through an MLE or VLE. The dotLRN environment permits QTI files to be used alongside SCORM resources. In ALPE project we used dotLRN own assessment tool, which is compliant to QTI, but we could have imported assessment defined on one of the other existing QTI tools.

### 2.3. Validate content accessibility

The accessibility validation requires several steps, some using automated tools and others that need to be done manually

The recommended methodology is:

1) Syntax validation, including xHTML and CSS, with automated tools
2) Accessibility validation using automated tools (at least 2 different tools)
3) Manual verification of the WAI guidelines that are not validated by automated tools. Possibility to use a tool named HERA
4) Manual verification in text mode browsers such as Lynx
5) Manual verification in graphic mode browsers such as Internet Explorer, Firefox, Opera.

6) Colours verification with tools such as GrayBit or Colour Contrast Analyser
7) Verification using technical aids such as JAWS screen reader or Magic magnifier
8) Verification of the content for spelling and grammar, language easiness and clarity, structure clarity
9) Verification of the navigation consistency

We have to be careful with automated tools. There is an important human component in the accessibility validation process. For example, an automated tool can force to include a text description for every image, but the tool just ensures that the tag exists and doesn't check the relevancy of the content. If the text to describe the image is "This is an image", the tool validates it although it doesn't provide any relevant information and therefore it is not accessible.

## 3. Education standard compliant content

In this section we introduce the educational standards and packaging tools.

### 3.1. Education standards

SCORM (Shareable Content Object Reference Model) is a technical specification that governs how an online training is created and delivered to learners. The essence of SCORM is that any content that conforms to the SCORM specifications will work with any SCORM conformant LMS (Learning Management System). It is now widely adopted and is the de facto industry standard.

SCORM defines a common reference model to comply with accessibility, adaptability, durability, interoperability and reuse of courses and other education materials.

The standards implicated are:

- the Information Management System Content Packaging standard (IMS-CP)
- the Institute of Electrical & Electronics Engineers for Learning Object Meta-Data standard (IEEE LOM), which define metadata scheme for multiple implementations
- the Information Management System Learning Resource Meta-Data standard (IMS-MD) which refers to IEEE LOM theoretical aspect and practical aspects, such as guides and tools With IMS MD, course materials are described by the basics characteristics: format, size, interaction level, difficulty, time estimate, language, or anything that can help search and locate resources to create a course.
- the Information Management System Question and Test Interoperability standard (IMS-QTI), which describe education material for evaluation (test, questionnaire, etc.)

ALPE platform facilitates reusing the content by complying with education standards : SCORM 1.2, IMS-CP 1.1.2, IMS-QTI 1.2.1, and IMS-MD 1.2.1. Although the dotLRN platform used in ALPE also support the IMS LD (Learning Design) standard, this standard is not used in ALPE for several reasons. One of the reason is that it is difficult for author to create courses complying with this standard. Refers to project aLFanet for more details [4]

### 3.2. Packaging tool: Reload

RELOAD is a project focused on the development of tools based on emerging learning technology interoperability specifications. It includes several open source tools for learning objects packaging and delivery used in ALPE.

For instance, the Metadata and Content Packaging Editor, enables users to organise, aggregate and package learning objects in standard IMS and SCORM content packages tagged with Metadata (in various subsets) and vocabularies.

RELOAD editor constitutes a key tool in the SCORM packaging process of ALPE services. It supports the packaging of html contents, together with other linked multimedia resources.

## 4. Methodology

The methodology for developing standard-based accessible courses, from the conceptual design to the SCORM package import to the platform was introduced in [6] and consists on the following steps:

**1. Design the course conceptually**

Define the course, activities, evaluation questionnaires and the way and the order of presenting them to students.

**2 Create the material**

Create the content, the activities and the questionnaires (IMS QTI) while taking into account the accessibility guidelines in 2.1. To guarantee accessibility, it is recommended to use an editor which output will be HTML 4.01 strict and later use a stylesheet.. We used Course Genie in ALPE, as well as other tools details in 2.2.: SMIL, MathML and QTI

The course's author is in charge of this step. In order to optimize this step of the process and obtain the most consistent and accessible output, we are creating a best practice document aimed at the courses' authors.

**3.Validate accessibility**

Validate accessibility of the all the materials. We recommend using the methodology described in 2.3 to validate accessibility, including syntax validation. This step is performed by the course's author and include both automated and manual verification.

**4. Define the instructional design**

Organise the course contents and define when the materials are to be used and how, while creating a structure in SCORM. Several editors exist, the most common is Reload. See details in 3.2

**5. Add metadata**

Add metadata to the content according to IMS MD. This means specify the nature of the contents to use them accordingly, indicating for example: difficulty level, interaction level, estimate of the time needed for completion. Those metadata can be added with the SCORM editor of the course such as Reload, or later with the own tool importing the SCORM package.

**6. Package the course**

Export the result of the previous tasks as a zip file that will contain materials, metadata, evaluation and information for instructional design following SCORM and IMS CP.

**7. Import the course on the platform**

Publish the course to the dotLRN platform, which supports SCORM and IMS Standards (IMS CP, IMS QTI and IMS MD), in order for the students to access contents according to the instructional design.

**8. Validate accessibility within the platform**

Test the accessibility of the course within the platform as well as the compatibility with technical aids such as Jaws, Supernova, Magic, or Braille line keyboard. Students or peers perform this evaluation.

## 5. Conclusions and future works

ALPE project aims at validating the market of an open-source, standards-based, accessible e-learning platform through the implementation of innovative and accessible human-computer interaction techniques to provide training to disabled and adult students that enable them to improve the fundamental knowledge needed for everyday life.

This paper has detailed the methodology followed to produce accessible, SCORM-compliant courses: production and validation process of the courses. See also [6] for more details. ALPE service tries to meet the needs of their target learners by providing the following key features: programmatic learning and the presentation of content to suit the learner's level of disability, alternative learning options, additional information to those who need assistance, and peer-to-peer learning when advisable.

An initial end-user evaluation has been performed and described in more detailed in [7]. More end-users evaluations are still to come with the goal of identify any accessibility issues, within a series of iterative evaluation. In total, 300 users will be

involved in that evaluation, 100 from each country implicated in the ALPE project (Spain, UK, Greece).

**Acknowledgments.** The authors would like to thank the European Commission for partly funding ALPE project (eTEN 029328), as well as the .LRN global community of educators, designers, and software developers

## References

1. Santos, O.C., Boticario, J.G., Raffenne, E., Pastor, R.: Why using dotLRN? UNED use cases. 1st International Conference on FLOSS: Free/Libre/Open Source Systems. (2007, in press)
2. WAI Content Guidelines for creating accessible web pages (WCAG) v1.0, available at: http://www.w3.org/TR/WAI-WEBCONTENT/, WCAG v2.0, (draft at time of writing), available at: http://www.w3.org/TR/WCAG20/
3. WAI Quick Tips to Make Accessible Web Sites available at http://www.w3.org/WAI/quicktips/Overview.php
4. Santos, O.C. and Boticario, J.G.: Meaningful pedagogy via covering the entire life cycle of adaptive eLearning in terms of a pervasive use of educational standards: the aLFanet experience. In the First European Conference on Technology Enhanced Learning (EC-TEL'06), p. 691-696, (2006).
5. Santos, O.C.: Technology Enhanced Life Long eLearning for All. In Maillet, K. and Klamma, R.: Proceedings for the 1st Doctoral Consortium on Technology Enhanced Learning. European Conference on Technology Enhanced Learning, p.66-71, (2006)
6. Santos, O.C., Boticario, J.G., Rodríguez Ascaso, A.. Gutiérrez y Restrepo, E. and Barrera, C.: Accessible and Reusable courses on ALPE Platform (available in Spanish). 1st International Conference on FLOSS: Free/Libre/Open Source Systems. (2007)
7. Santos, O.C., Barrera, C., Gutiérrez y Restrepo, E., Granado J., Martin L., Raffenne E., Rodríguez Ascaso, A., Boticario, J.G.: Outcomes from a SCORM based course in dotLRN accessible platform. OpenACS and .LRN Spring Conference, Vienna 2007