Methodologies and scenarios

Continuously updated e-learning material through easy authoring processes

Angelo Di Iorio, Antonio Feliziani, Silvia Mirri, Paola Salomoni and Fabio Vitali

Department of Computer Science, University of Bologna

{diiorio|afelizia|mirri|salomoni|fabio}@cs.unibo.it

Abstract

The «Anywhere, Anytime, Anyway» slogan is frequently associated to e-learning with the aim to emphasize the wide access offered by on-line education to students. Our aim is to extend the reach of this sentence to content authors as well. Our idea is to produce tools to simplify drastically the task of creating, updating and publishing content for e-learning courses, and to allow them to produce learning objects of extremely high technical sophistication directly from off-the-shelf desktop application. Thus we introduce ISA-BeL, a conversion engine that can generate standard-based, visually homogeneous, accessible and graphically sophisticated SCORM learning objects by analyzing the internal structure and content of word processing files and generating the required output without requiring particular technical awareness by the user.

Edizioni Erickson – Trento
www.erickson.it

Je-LKS Journal of e-Learning and Knowledge Society — *Vol. 2, n. 3, novembre 2006 (pp. 315-329)*

1. Introduction

The generation of high quality learning material is incredibly expensive: the thoroughness of the actual content must be accompanied by thought-provoking prose, stimulating rhythm, eye-catching video and animations, enriching interactive exercises and games, and stylish yet classy presentation and graphics. Of course a largish team of devoted professionals with good management, sophisticated state-of-the-art tools, plenty of time, and lavish means can provide educational material of excellent quality, built to impress, educate and entertain generation after generation of students.

Unfortunately, we e-learning course planners and builders are not always able to afford such project logistics and expenses. Depending on the kind of money available, we end up renouncing to professional directors, animators, writers, programmers, project managers, graphic designers, and rely on low-cost substitutes in their stead, such as students, colleagues, ourselves, playing all these different roles to the best of their and our abilities, whatever they are.

At the same time, the stakes keep getting higher. Not only we have to prepare fascinating courses of high educational standards, but new and sophisticated and required expertise must be gained just to keep up with regulations, expectations, technical evolutions. Consider, for instance, the impact of these two recent and relevant requirements on the difficulty of course authors' jobs:

1. *accessibility*: producing fully barrier-free learning contents is one of the key issues to meet the goal of an inclusive «knowledge society»;
2. *portability*: conformance to e-learning standards enhances contents portability and is recognized as one of the fundamental aspects to preserve contents value over time.

Existing authoring tools, because of several different reasons, still fall short in providing an environment that is both capable of dealing with all the appropriate technical aspects and, at the same time, as easy to use as can be expected to be understood and mastered by an eager but non-professional computer user.

How should the ideal authoring tool be, in order to fully assist educators in creating accessible content for modern Learning Management Systems? What kind of support could we build for users that do not really want to deal with all the technical details of current e-learning technologies? We have identified at least seven dimensions:

1. *ease of use*: the tool should be at least as easy to use as existing word processors and presentation tools, so as to lower its learning curve;
2. *ease of re-use*: the tool should help and assist authors in reusing and converting to the new e-learning platforms existing documents and material they have already prepared in past times by using standard desktop tools;

3. *ease of editing and updating*: the tools should aid in the continuous modification, improvement, and enriching of course material, and help in providing a fast and direct route to publication of updated material;
4. *standards support*: the tool should generate learning objects that can be read by a large variety of commercial and open source e-learning platforms, being they produced according to some major e-learning standards;
5. *visual Homogeneity*: the tool should produce content that easily undergoes platform- and site-specific styles and look&feel, by fully and easily adapting any content to the templating and styling locally mechanism adopted;
6. *universality*: the tool should generate content which can be fully and at best quality displayed on a wide variety of applications, including non-dominant versions of browsers and operating systems, older versions of browsers and operating systems, new and emerging hardware devices;
7. *accessibility:* the tool should create fully accessible content according to international standards and national laws.

In this paper we concentrate on the issues connected to *ease of re-use* and *ease of editing and updating* of existing e-learning content. In particular, we discuss the all-too-frequent situation of a course author that would like to bring in the course the content of existing WP files and presentation, and do so in an iterative way: converting, testing, changing, re-converting, re-testing, re-changing and so on.

When this is done by a team of devoted professionals with state-of-the-art technical tools, plenty of time and lavish means, one can expect negligible costs and excellent and breath-taking results at the end of the very first iteration. But when constraints exist on means and time, a more likely process is the conversion of existing material as the first step of many where the content is edited, messaged, cut, proof-read, readied, published, tested (possibly even by actual students), and then edited again, re-messaged, re-cut, etc.

Clearly in such processes the ease of use of an authoring platform is of paramount importance. Widespread authoring applications provide editing interfaces on the final output of the publication, the learning object. This creates a thorough fracture between accessing and using the original content in the original format (before the conversion) and the updated content in the authoring platform (after the conversion), and makes the conversion a pivotal event in the workflow, the event after which, for obvious economic and practical reason, we are forced to use the authoring platform for all subsequent editing and updating.

In this paper we present a methodology and some tools for the creation and management of accessible and universal learning objects (LO) which modifies the authoring relationship with the content conversion. In our approach the authoring environment is an automatic conversion engine that generates high quality, visually homogeneous, standard based and accessible content out of the content

of standard desktop applications such as word processors and presentation applications. ISA-BeL, designed and implemented to support automatic production of standard compliant e-learning materials, therefore allows authors to keep on using the original files and modify and update them, without creating a fracture between the original files and the converted ones. This greatly simplifies the tasks related to content re-use and update, and allows the authors to keep on using the original applications and interfaces. The process has been widely used to publish more than 200 learning objects which are currently in use by our university and other institutions for several e-learning activities in a number of subjects, from computer science to business sciences. Accessibility of the whole process and of all the produced LOs has been verified on the field.

The remainder of the paper is organized as follows. Section 2 provides some background information about authoring e-learning content platform. Section 3 introduces the creation and management process in e-learning contexts using ISA-BeL. The final section provides some conclusions and suggestions for future works.

2. Background

2.1 Systems and standards

Systems providing e-learning services can be divided in two main categories: LMSs (*Learning Management Systems*), which are web-based platforms by actually providing content to the users and LCMSs (*Learning Content Management Systems*), the authoring environments used to create learning objects. The main features of an LCMS are related to the content management, from the production to the storage including reusability and distribution of content. On the other hand an LMS manages the administrative functions, the distribution of contents to learners, and the tracking of the learners' experiences and assessments.

A relevant role is played by existing e-learning standards, in ensuring interoperability and reuse of didactical materials. Main interoperability specifications have been developed by IEEE (Institute of Electrical and Electronics Engineers), with a specific working group, the Learning Technology Standards Committee, which is working on e-learning standardization (IEEE LTSC WG12, 2006) and IMS (Instructional Management System) Global Learning Consortium (IMS Global Learning Consortium, 2006).

A relevant role is also played by Advanced Distributed Learning (ADL) initiative (Advanced Distributed Learning, 2006), which has developed a de-facto standard called SCORM (Shareable Content Object Reference Model) (Advanced Distributed Learning, 2004c), based on some specifications previously defined by IEEE-LTSC and IMS.

2.2 Learning Object Production

An interesting field in e-learning research is the simplification and automation of the learning objects production. Several projects and products provide authoring tools (4system, 2006; ReadyGo Inc., 2006; SumTotal Systems Inc., 2006). They give authors different interfaces and functionalities so that they can create e-learning materials, manage resources, add metadata, and so on. In many cases, the use of these new tools cannot be fully appreciated by authors, who may prefer to rely on well-known productivity tools, which could allow them some savings in time and money. Products and platforms are designed by moving onto this direction and they generate e-learning course materials starting from well-known productivity tools, such as Microsoft Word (Horizon Wimba, 2006; Serco, 2006). The main advantage in exploiting such products is that no learning and training phases are needed. On one hand these tools provide a too rigid structure in drawing up created contents, on the other hand they keep authors' stylistic choices, instead of maintaining only designers' ones, invalidating accessibility and usability principles. One of these products (Horizon Wimba, 2006) provides a partial support to accessibility of created contents, but, in some cases, generated LOs are not compliant to international guidelines and laws, denying actual benefits to learners with disabilities.

Generative Learning Objects (GLOs) (Boyle et al., 2004; Bradley et al., 2004;) follow a different direction. The underlying idea is based on the division into two different parts the LOs creation. The first one consists of building a Learning Object Template (LOT), while the second one is devoted to adding the template a subject specific content. The LOT encloses the deep general structure of the e-learning course. Once a template has been created, authors and/or tutors can add different subject specific contents, i.e. the surface structure, so as to produce Learning Objects which fit the specific fields of the discipline.

A new way to think intermediate data format is promising to have an interesting impact on LO production: Microformats (Microformats.org, 2006). Microformats are a set of simple open data format standard which are developed and implemented for more/better structured web microcontent publishing. In (Downes, 2006) authors propose Microformats use in e-learning, by conceiving it as a network phenomenon, so as to facilitate a personal e-learning centre design.

Other academic works are devoted to produce accessible (according to W3C Web Content Accessibility Guidelines [World Wide Web Consortium, 1999c]) and personalized e-learning content. One of these proposes the design of a prototype which drives authors in creating accessible didactical materials (Gabrielli et al., 2005). The authoring interface of this prototype is developed in Java and its main aim is to support authors' job with suggestions and examples. ELENA (Dolog et al., 2003; Dolog et al., 2004) supports personalized access to distributed

learning repositories. The approach to customization employed in this project takes advantage of semantic Web technologies and metadata description standards, such as LOM (IEEE LTSC WG12, 2002) and IMS AccessForAll Meta-data (IMS Global Learning Consortium, 2002a). In addition, it adapts and customizes access, delivery and consuming of learning services and LOs on the basis of rule-based matching of contents and learners descriptions.

3. From content creation to e-learning delivery

3.1 A simplified authoring architecture

The problem of producing usable, accessible and universal content goes beyond the only e-learning context.

It is an expression of a long-term discussion: the tension between the authors' expertise and the quality of the final documents. Although an ideal and automatic publishing system should both minimize users effort and ensure high-quality results, in practice, trade-off solutions need to be taken by designers. We have identified three different editing models:

1. *pre-structured editing*: users are totally driven during the editing process. Examples are those systems where authors add content by filling forms, by inserting predefined set of data, by using *ad-hoc* editors and so on. High-quality results are simpler to be achieved (since few errors occur) but users are more limited and need to learn new tools;
2. *un-structured and totally free editing*: on the opposite edge of the spectrum, users are entitled to write content with their preferred tools and schemas, without following any rules. The system is in charge of extracting content and transforming it into high-quality output. The expertise required to the users is very low, their freedom is unconditioned but the overall result depends on the extraction capabilities of the system;
3. *aided editing*: a softer approach consists of helping authors in writing content and respect some rules, that make conversions simpler and more reliable. Examples are those systems based on detailed guidelines, hints and macros, meant to help and drive authors, without imposing them any forced path. Such a model can be defined as «GIGO» (Good Input, Good Output): the more the input is well-structured (and the system give users precise and fine-grained helps to do that), the more the output will be good and reliable. On the other hand, authors are free to ignore such suggestions, to the (possible but not sure) detriment of the final quality of the documents.

We propose a solution positioned between the *aided editing model* and the *un-structured editing* one: letting authors to use their productivity tools to write documents and automatically extracting, re-flowing and transforming the content.

Such a solution relies on a basic but strong assumption: a limited set of constructs and elements can always gather the actual information (content) of any document regardless of its storage format and formatting. We consider the layout and the storage format as extra layers which can be modified and substituted at any time, without impairing the real information. For instance, a paragraph with style «title» in MS Word, a fragment <h1>The Poem</h1> in HTML, and the fragment <title>The Poem</title> in XML, or an emphasized paragraph in PDF are all equivalent.

Then, we have designed a very simple language, called IML (Intermediate Markup Language) aiming at capturing only such actual content and structuring it into a set of sub-components (space limits prevent us to go into deeper details on IML, more details in Di Iorio, 2005b).

On the basis of the simplicity, minimality and power of IML, we propose a flexible architecture based on the *superior standard model* (Diaz, 2002): in order to transform a document from format A to format B, this is first transformed into an intermediate format S and, then, into the final one. As expected, the role of intermediate language is played by IML. The following picture summarizes our schema:

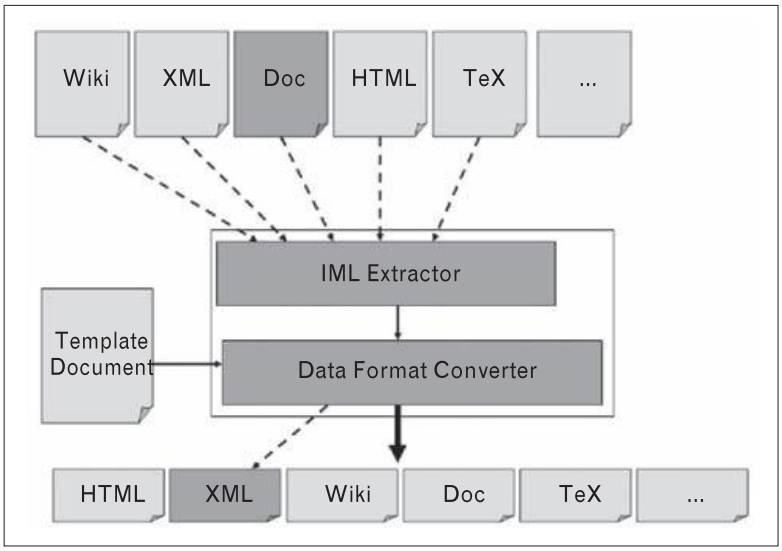

Figure 1 The general conversion schema instantiated by ISA-BeL.

We have implemented different applications based on the same architecture, conversion engine and internal language. ISA (Vitali, 2003) is a content management system that simplifies and speeds up the creation of web pages, by letting authors to write content with MS Word. Graphic designers are simply required to draw layouts and associate content with their position, while the system is in charge of merging these two components into the final result. IsaWiki (Di Iorio, 2005a) is a complex platform aiming at simplifying and strengthening the

editing model of the World Wide Web, by moving it into a writable platform, where all users can write and customize content regardless of their skills, tools and locations.

ISALearning is an authoring system customized for the e-learning context, based on our general schema (in the picture, the IsaLearning workflow has been remarked with a stronger grey). Authors write content, by using Microsoft Word and Power Point, that will be automatically transformed into portable learning objects. Actually IsaLearning is a sub-component of a complex system that produces SCORM objects from an intermediate XML output. We call the whole system ISA-BeL.

3.2 Context: the A³ Project

Before describing ISA-BeL we need to introduce the context where the system has been developed and used: the A³ project. Teaching basic computer knowledge is becoming a matter of big interest in a lot of fields, particularly in Universities, where in every degree course is necessary to certify a minimal skills in computer knowledge. For this reason, the Department of Computer Science at the University of Bologna has developed a project (called A³, Accessible Learning Environment [University of Bologna, 2004], «*Ambiente Accessibile d'Apprendimento*» in Italian language) for the creation and fruition of contents taking in a particular account the training structure uniformity, a low management cost, and a little effort in resources and time consumption for the process startup. Two requirements related to LOs used in A³ are due to:

- *Accessibility and Web standard compliance*. The project was developed and carried out inside an Italian University and it respects the Italian Law on Information Accessibility, the so called «*Stanca Act*» (Italian Parliament, 2004).
- *Portability of LOs and e-learning standard compliance*. Learning objects produced in A³ are package SCORM 1.2 RTE compliant (Advanced Distributed Learning, 2004b), so that contents can be imported in every LMS SCORM compliant.

3.3 Semi-automatic production of e-learning content: ISA-BeL

ISA-BeL (Di Iorio et al., 2005) is a chain of tools, which allows users to easily create accessible and portable learning objects. ISA-BeL author writes a document of raw content and he/she indicates the role of each fragment (by using styles according to a set of given guidelines), and the conversion engine transforms each fragment in a proper element of the final learning object. Actually, information about the whole output structure as well as some metadata are required, but inserting such data is really simple and fast, as we will discuss later.

A three step workflow has been defined for ISA-BeL:

1. *Authoring* (*Content creation*), done by teachers using a word processor (or alternatively a different personal productivity tool, such as a presentation application).The output of this phase is a set of documents in common formats like rtf, doc, ppt, sxw, etc.
2. *Producing* (*Content transformation*), i.e. the process creating a LO from a set of documents produced during phase 1. The output of this phase is a LO which has to maintain accessibility features embedded in original documents.
3. *Delivery* (*Content distribution*), the real e-learning service, provided by a LMS which guests the LO which is produced in phase 2. The LMS has to guarantee accessibility of content and service provisioning.

The whole process is depicted in figure 2, which also shows the content production step performed by ISA-BeL. The output of ISA-BeL is not a simple set of common HTML pages, but a group of several alternative contents, which are used to enhance portability and accessibility, such as Learning Objects compliant to SCORM-CAM 1.2 or 1.3 (Advanced Distributed Learning, 2004a), web-based materials or printed materials obtained from the original contents by using XSL-FO.

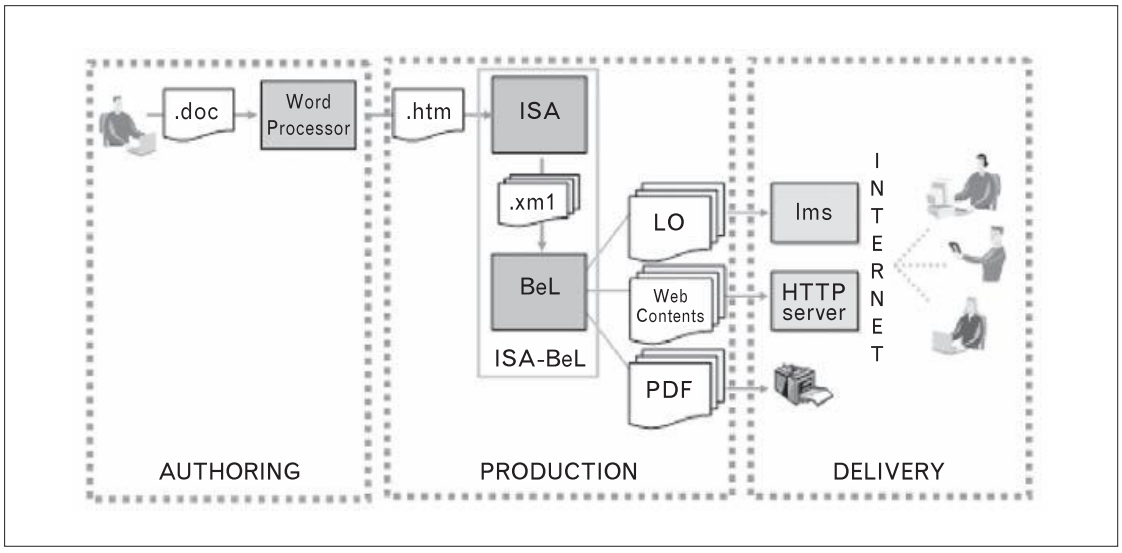

Figure 2 Authoring-management-provision of accessible e-learning by means of ISA-BeL.

3.4 Authoring

The ISA-BeL support for content creation consists of providing users an alternative and simplified way to express all the data and content useful to create learning objects. Focusing on the resources packaging (even if the whole project we are working on currently supports tracking, run-time monitoring and assessments

management too), a learning object can be defined as *a set of structured resources* supplied with a *(SCORM) manifest* that describes them.

From this definition, we figured out alternative mechanisms to (i) indicate which pages compose the learning object and which content elements compose each page, (ii) verify these content elements express all the required information and (iii) add metadata associated to the learning object.

An ISA-BeL author, in fact, is assisted by three different tools, specifically designed to cover these three aspects:

- An *authoring toolbar* which offers a fast access to him/her main activities such as defining presentational aspects and structural elements, inserting accessibility related information and so on.

Figure 3 The ISA-BeL authoring toolbar (in MS Word).

- A *verification toolbar* which runs controls over the respect of accessibility and universality constrains. Such a sidebar has been introduced to meet accessibility requirements but it is an optional component.

Figure 4 The verification toolbar.

- A set of forms to collect SCORM Metadata. While some of them can be derived by the system (last-saved date, file size, language, and so on), other information have necessarily to be provided by the authors. The interface has been designed according to the principle of giving users the possibility of completing their tasks without having to learn new technologies and tools.

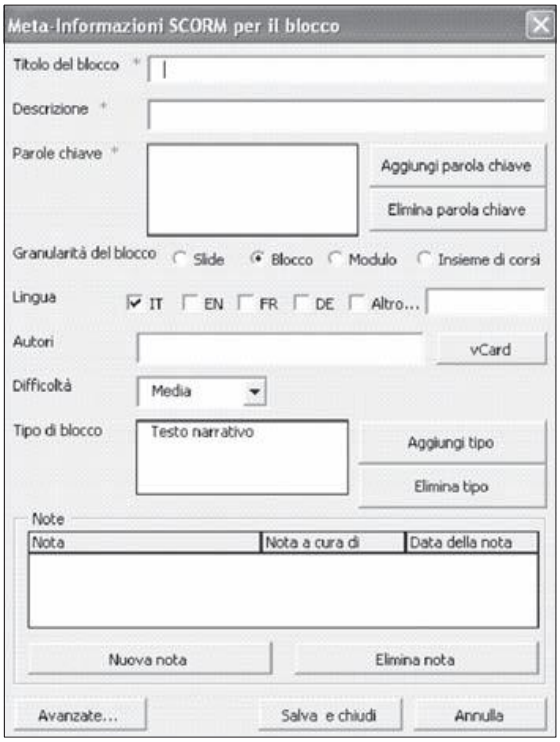

Figure 5 The form for Meta-Data.

3.5 Production

The production process is performed by an *ad-hoc* application, ISA-BeL which is composed of two modules:

- *ISALearning*: a conversion tool which actually transforms document from the word processor format into an intermediate XML representation, enriched by all the necessary metadata. The correct usage of MS Word styles, supported by macros and toolbar provided by the system, ensures and makes simpler the overall transformation process.
- *BeL (Backed e-Learning)*: a stand-alone application which gathers all the information stored in the intermediate XMLs, creates the SCORM structures (in particular the tracking scripts and the manifest file) and merges the content into a single .ZIP file, by processing the output of ISA. BeL also integrates into the LO a (multimedia) recorded accessible video lecture, which is automatically transcoded through a different line of the LO production(Salomoni et al., 2005).

The production process is based on a set of templates and configuration files which are used to define structural aspects as well as layout and graphical aspects of the automatically produced LO.

Figures 6 and 7 show an example of a Word file produced by an A³ author, transformed into an HTML page and loaded on the e-learning platform.


Interruzione di sezione (continua)

Bitmap e vettoriale

La grafica digitale può essere resa in due modalità:

- La grafica bitmap (o raster) memorizza le immagini usando i pixel, per cui la composizione avviene come in un mosaico, e la memorizzazione mediante matrici (griglie) di punti e colori.
- La grafica vettoriale memorizza invece le immagini a partire da formule matematiche che contengono le istruzioni necessarie per tracciare linee, curve, ed aree, per cui la colorazione risulta più precisa e netta rispetto alla grafica bitmap.

La grafica bitmap si presta meglio alla visualizzazione su video in quanto il monitor è formato da una griglia; inoltre, questa modalità grafica riesce a rendere con qualità maggiore immagini con un numero elevato di colori o con texture complesse, come ad esempio le fotografie. La grafica vettoriale è invece più definita e di qualità maggiore, soprattutto per rappresentare disegni semplici, con sfumature di colore non molto elaborate.

img/image011.gif

Differenza tra immagine bitmap e vettoriale

La figura mostra il disegno di una busta, resa in modalità bitmap e vettoriale. Il disegno bitmap è una griglia di punti, in parte colorati di nero. I punti neri formano il contorno di una busta chiusa. Nella grafica vettoriale la stessa forma è resa mediante linee continue.

Interruzione di sezione (pagina successiva)

Figure 6 The page created with MS Word.

Figure 7 The same page rendered by a LMS.

3.6 Delivery

Contents which were produced by the automatic process are loaded on the e-learning platform as SCORM LOs. Our choice has been made between the large number of open-source platforms and, after a deep testing period, we have adopt

ATutor platform (Adaptive Technology Resource Centre, University of Toronto, 2006). The choice has been driven by the built-in usability support even though it has been necessary modifying the platform to adapt it to the Italian Law on accessibility which is narrower than the Canadian one. Accessibility of the adopted LMS partially guarantees that produced contents maintain accessibility features and ensures accessibility and portability of services (chat, forum, news). Some modifications were needed to completely meet the «Stanca Act» requirements, and particularly the constraint to use Strict (X)HTML code.

The main delivery of A³ was through the LCMS, but ISA-BeL produces also a printable version and a fully HTML one.

4. Conclusions and future works

The need for simplicity in knowledge creation and sharing has been a basic concern in the international e-learning community. This paper presents a content creation and management process allowing authors to easily produce accessible and portable LO by relying only on personal productivity tools.

ISA-BeL provides support to the content authors with regard to the seven main dimensions listed in Section 1: it allows author to edit contents, reuse existing materials, update source files, and generate sophisticated output. The tool supports the best known conciliation between e-learning standard and accessibility guidelines, so as to guarantee portability through LCMS together with the respect of WCAG (AA level) and of the Italian Law on accessibility.

Our main future work is devoted to extend the functionalities of the system, by offering supports in creating more complex contents to the authors, by ensuring accessibility and universality of the results together with simplicity of usage.

Acknowledgments

This work was partially funded by MIUR (Italian Ministry of Education, University and Research) and was supported by CRIAD (www.criad.unibo.it). Authors want to thank Lorenzo Donatiello, Simone Martini, Marco Roccetti, Nelda Parisini and all the colleagues that supported this work with their precious suggestions. Finally authors want to thank ASPHI Onlus Foundation (www.asphi.it) that supported tests with users.

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