Ferrari *et al. Technol Innov Educ (2015) 1:1*
DOI 10.1186/s40660-015-0002-0

Technology, Innovation and Education
a SpringerOpen Journal

CASE STUDY Open Access

On supporting e-learning in the field of resilience management with an open source authoring tool

Luca Ferrari[1*], Luigi Guerra[1], Silvia Mirri[2], Silvio Olivastri[3] and Paola Salomoni[2]

*Correspondence:
luca.ferrari15@unibo.it
[1] Department of Education, University of Bologna, Via Filippo Re, 6, 40126 Bologna, BO, Italy
Full list of author information is available at the end of the article

Abstract

Among all the pedagogical and technological features that could be used with the aim of improving and making more effective online education, we have identified virtual and augmented reality-based technologies and the creation and sharing of digital open resources as interesting issues not yet adequately covered. Both of them can be exploited in the current and trendy Massive Online Open Courses (MOOCs) scenario, so as to make their content and activities more interactive and effective. Furthermore, a key role is played by all the online tools (authoring tools / pedagogical planners) that support, on one side, authors in creating contents and, on the other, learners in exploiting them while they are acquiring skills and competencies. We have designed, developed and customized an e-learning authoring tool, called BEAT (Bologna E-learning Authoring Tool). This paper focuses on main design issues and on the customization of BEAT devoted to meet the needs of the RESINT project, with the aim of supporting authors in creating (designing and editing) and managing interactive and Open Educational Resources. One of the expected results of this project is to create an open source authoring tool to support authors during the creation of open learning objects, accessible (and reusable) through Learning Content Management Systems. A use case in the context of resilience management-related topics is also illustrated in the paper.

Keywords: E-learning authoring tools, Learning objects, Templates, OER, MOOCs

Introduction

Today more than ever, many pedagogical and technological features could be exploited with the aim of improving and making more effective the opportunities of distance learning. Among them we can identify the use of virtual and augmented reality-based technologies, but also the possibility of creating and distributing digital open resources. Both of them characterize the increasing scenarios of Massive Online Open Courses (MOOCs). In this context, a key role is played by all the tools that support authors in editing and managing e-learning content and activities. Such authoring tools can be online or offline, and should offer an adequate support to the design and the creation of open (digital) educational resources, which should be compliant with the most common and well-known international e-learning standards (Mirri et al. 2011).

Several works have been done with the aim of exploiting virtual and augmented reality technologies in the context of e-learning and distance education. From medicine,

to astronomy, from engineering to geometry, from anatomy to chemistry, several disciplines and topics can take advantages by exploiting interactive technologies: ranging from 3D objects reconstruction to Second Life environments, from immersive virtual reality to remote collaborative augmented reality (Lucke and Zender 2011; Trelease and Nieder 2013; Hesse and Gumhold 2011). Such a plethora of technologies are not yet taken into account by e-learning standards and by the most commonly used Learning Content Management Systems (LCMSs) and e-learning authoring tools, even if they are at the basis of several prototypes which have been studied with the aim of improving e-learning effectiveness. Some prototypes have been designed and are still under development in the context of resilience management-related topics too. For instance, within the RESINT project, an augmented reality model has been defined. But there is still the need of standardized online platforms which can support on the one hand authors in creating such kind of content in an open way and on the other hand learners in exploiting them while they are acquiring related skills and competencies.

The term Open Educational Resources (OER), coined at UNESCO's 2002 Forum on the Impact of Open Courseware for Higher Education in Developing Countries, labels teaching, learning and research materials in any medium (digital or not) which is available, released under an open license that permits free access or use. Since the establishment of the European Higher Education Area, European Universities have expanded their activities within different areas of collaboration and cooperation around course provision and joint degrees. Furthermore, according to Miller (2011), the opportunity for faculty members and institutions to openly share content beyond traditional institutional boundaries has also grown into an international movement. Nowadays, the European Union governments are fostering awareness of OER though the promotion and use of these resources to widen access to education, whether formal, informal or non-formal, with an emphasis on lifelong learning, to contribute to social inclusion, gender equity and special needs education. If we accept to face the challenge of OER in Higher Education, it is essential to change or modify our educational perspective, including finding creative solutions to shift from prescriptive educational methods towards open learning formats (Ferrari and Traina 2013).

A relevant topic of the above-mentioned scenario concerns, for instance, the mismatch between free access to the so called Massive Open Online Courses (MOOCs) and the level of openness and reuse of its digital contents. Clearly, the free access in a massive course does not usually match with the gratuity (Chiappe et al. 2015). By taking in account this example, we can underline that while access to massive online open course is free, the opportunity to access content without costs does not imply, in some cases, the possibility to re-use content in other contexts, to edit or to combine them into other digital products to create new educational resources. This is one of the RESINT project challenges. Unfortunately, in most of the cases, both contents and platforms are characterized by closed policies of copyright, which prohibits for instance, the use, re-use and distribution of digital learning contents. While the European Union invests (from economic and cultural points of view) to promote politics and practices related to the diffusion of Open Educational Resources (OERs), we can notice that most of the eLearning/MOOCs experiences are "closed". Taking into account this issue, one of the expected results of the RESINT project is the development and the distribution of an

open source authoring tool (with a clear pedagogical and technological foundation) to equip e-learning authors with the creation of OERs, which would be accessible—and reusable—through Learning Content Management Systems (LCMSs).

In this scenario, we have designed, developed and customized an e-learning authoring tool, called BEAT (Bologna E-learning Authoring Tool) and based on the open source AContent. The main goal of BEAT is to support authors in creating and editing open didactical materials and online and interactive activities. Currently, functionalities devoted to let the author create interactive activities and virtual and augmented reality-based learning objects are still under development, while we have completed the mechanisms to create open content and activities. This paper presents main design issues and the customization of BEAT dedicated to the RESINT project and shows a use case in the context of resilience management-related topics.

The remainder of the paper is organized as follows: "Background" presents the background and the concepts at the basis of BEAT. "BEAT: design issues and implementation" describes main design issues and BEAT implementation. "Case description" shows a BEAT use case, while "Discussion and evaluation" concludes the paper.

Background

In order to produce effective e-learning materials and activities based on the open resources, which are interoperable, re-usable, compliant with the most common e-learning standards (Mirri et al. 2011) and which exploit interactive and innovative technologies, it is fundamental to equip e-learning authors with an adequate and complete authoring tool. Such a tool should support authors both in the content design and content creation phases (Boni et al. 2006). The choice of a specific authoring tool has a significant impact on the final quality of e-learning products (Di Iorio et al. 2006) and this is particularly true whenever it is used by large organizations to produce content on a wide scale or when Massive Open Online Courses (MOOCs) are offered. An effective e-learning authoring tool should provide an adequate support to (Guralnick and Levy 2009): (1) the compliance to e-learning formats and standards, to ensure the content portability through different e-learning platforms/systems, so as to make it interoperable and re-usable (Ferretti et al. 2008); (2) the creation of new content as well as editing of existing ones, without forcing the author to acquire specific technological skills (Di Iorio et al. 2008); (3) reduce the learning curve to learn how to be used by authors. A mechanism which can be exploited with the aim of supporting authors in designing effective e-learning content and activities (both in terms of educational aspects and technological issues) is based on the use of templates, which can be provided to the author by means of wizard or interactive Graphical User Interfaces (GUIs). Such a mechanism is usually implemented by means of a specific engine which can be embedded in the platform that delivers and manages the content, but templates in the e-learning context have to deal with e-learning standards. This means that they have to be compliant with the mechanism of packaging standard content, making them self-contained and platform independent. Hence, templates in the e-learning context have to be autonomous and not linked to specific template engines provided by some Learning Content Management Systems or by some repositories: they have to be exploited in the design and editing

phase to create the content (Hui and Liu 2005) and they have to be included in the content package.

We can observe several advantages derived by the templates introduction in e-learning authoring tools; among the main ones there are the support to authors in designing and creating a learning object (template mechanism augments the usability of the authoring tools and can provide a more effective way to create learning objects) and the availability of a set of rules to be followed. This latter one is generally useful, but it is actually necessary whenever content are produced on a large scale and some qualitative/quantitative standards have to be met by all authors. Again, simple characteristics can be in charge of the graphical aspects of content, others, more complex, to didactical proprieties of the content itself (e.g. methodology, goals description, assessment). E-learning activities which require different sets of given standards could be easily and effectively created by providing authors with several templates (Aust and Meyen 2005).

In this context, after having taken into account different authoring tools (such as EXe-learning http://exelearning.org/, MyUDUTU http://www.myudutu.com/; HTMLArea (http://moodle.org/plugins/view.php?id=9 and MS LCDS http://www.microsoft.com/learning/en/us/training/lcds.aspx) we have chosen to work on AContent (http://atutor.ca/acontent/) and to design and developed an extension we have called BEAT (Bologna E-learning Authoring Tool), to support authors in creating open, interoperable, standard and interactive learning object. The choice of AContent has been driven by different reasons: it is open source; it is Web-based; it produces content compliant with the most common e-learning standards.

BEAT: design issues and implementation

The main aim of BEAT (Bologna E-learning Authoring Tool) is to support authors in creating e-learning content, by ensuring pre-defined level of technical and didactical quality and by providing a certain level of standardization among all the created learning objects (in the context of the same class or of the same course). In this context, the use of templates is the solution that better answered these needs. In fact, templates are at a same time a support to a flexible and easy content creation and a tool to provide authors with suggestions, supports and methodologies in designing and producing e-learning content.

We decided to exploit a problematic didactic model in e-learning training paths, echoing the topic of pedagogical problematicism and defining a complex hypothesis which can emphasize the integrated coexistence of different didactic strategies referring back to a problematicist matrix (Bertin 1968, Guerra 2010). The theoretical foundation of this model explicitly recalls the main learning theories and their critical interaction.

Hence, in this paper we propose a model we have applied in BEAT, which is based on the possibility of defining three main learning paths, by focusing, respectively, on the object, the process and the subject of learning (Guerra et al. 2008). In order to support didactical material authors in creating e-learning content by means of the BEAT authoring tool, we proposed a structure template which equipped authors with a predefined organization of the learning objects as for goals, content, assessments, tools, references, etc. The proposed approach is suitable in supporting authors, let them create content taking into account pedagogical and didactical aspects, not only technical point of views.

At the same time, such an approach does not constrain the author, letting him/her freely choose a specific methodology, in particular the most feasible and suitable one, according to his/her didactical needs.

In order to address these issues, we worked by coupling template philosophy with different mechanisms. In particular, we designed and implemented in our BEAT the following ones:

- *A three-layer templates architecture* Such an architecture is top-down organized; in particular: (1) each e-learning content can be created on the basis of a structure template which provides a predefined organization of the learning object, articulated in goals, content, assessments, activities, tools, references and so on; (2) each page of the learning object is associated to a page template, which outlines and divides the specific content of that page into sub parts. Such a kind of templates has been designed on the basis of the commonly used "slide layout"; (3) each page content is associated to a page layout, with the aim of defining graphical and stylistic aspects.
- *Editable/non-editable elements* The templates are coupled with specific tools and specific method to let the authors edit them. In particular, we have considered editable and non-editable elements. For instance, each page template is editable, this means that the page structure can be associated to a page template and then it can be changed. In this case the template can be exploited with the aim of supporting authors, but without introducing specific constrains and limitations. An example of non-editable elements is represented by some items which are mandatory in a learning object structure: the author has to fill in such mandatory items in a specific page and cannot remove that page from the structure of the didactical content (a typical example is the page where the goals of the content are described). This is the case of using the template with the aim of forcing authors, on the basis of a specific didactical method. Similar constrains can be set with the aim of forcing authors to be compliant with some technical standards (e.g. providing textual alternatives to non-textual content for accessibility related purposes, so as to provide the same didactical content also to those learners who are visually impaired). Other constrains can be expressed in terms of minimum and maximum numbers of items in a specific container, e.g. to be sure there will be from 3 to 6 final assessments.
- *Wizards* we have designed and implemented wizards to provide authors with an easy step-by-step creation of content function, supporting them in exploiting the tree-layer templates architecture, in choosing the proper structure for their learning objects and in explaining how to better use and fit editable and non-editable elements in this creation phase.
- *Authoring Permissions* in order to modulate authoring capabilities and related proprieties on editable and non-editable items, we have introduced some editing permissions in the author's profile provided by AContent.

The following subsections detail about the BEAT characteristics which we have exploited with the aim of providing a customization tailored for the RESINT project, in the context of creating and offering didactical content and activities related to the topic of the resilience management. In particular, the three-layer templates architecture, with

specific attention to the learning objects template structures. A more detailed description of the wizards can be found in "BEAT: design issues and implementation", where a case study is illustrated together with a learning object step-by-step creation.

A three-layer templates architecture

In order to support authors while they design and create didactical, BEAT provides three different levels of templates:

- The *layout template*, which lets the author select and apply a graphical layout to the content. The layout templates are basically implemented by means of Cascading Style Sheets (CSS) that can be added to the page. They exploit the cascading mechanism and they apply it, by merging the defined layout template with the Learning Content Management System (LCMS) graphical design. Layout templates can be applied to the whole content or to a single page of the learning object. Such options relate to two different authoring requirements: (1) the need of setting a consistent graphic design to a whole content and (2) the possibility of showing a specific page with some specific graphical details (for instance, the need of highlight some parts of the content or the need of aligning some content in a specific way, such as images).
- The *page template*, which supports the author in composing content pages. Such a kind of templates has been designed on the basis of what the main slides creation office automation tools calls as "slide template". The author can select the page structure among several already available ones and, starting from that, he/she can edit the structure by adding and/or removing some parts of it. From a technical point of view, each page template is substantially an HyperText Markup Language (HTML) fragment (which has to be included into a <body> element), compliant with HTML standards.
- The *structure template*, which equips the author with some predefined learning object structures, by defining some specific elements as mandatory or not (such as the goals, a content overview, a set of assessments, etc.). This mechanism has been inspired by some of the analyzed authoring tools (including MyUDUTU and MS LCDS). By means of different mechanisms, these applications equip content authors with different ways to create empty standardized lessons, starting from a set of predefined models. BEAT let the author create their learning object by exploiting a structure template. This kind of templates are based on the manifest used to define the learning object organization and they are organized as a hierarchy of pages. Each page can be associated with a page template. Each page of a given structure can be mandatory or not. Mandatory pages cannot be removed from the learning object. More details about the structure templates designed and implemented as a customization for the RESINT project are presented in the following pages.

Examples of these templates at work can be found in the following "BEAT: design issues and implementation", entitled "A Case Study". More technical details about these templates implementation on BEAT can be found in (Salomoni et al. 2012). The BEAT customization for the RESINT project is on line here: http://beat.resint.eu.

Learning objects structures

In addition to the three-layer template architecture, BEAT provides a sustained design procedure to drive the author during the learning object creation process. With the aim of better supporting the author in the choice of the most suitable structure template, we have associated some verbs to each learning model. In particular, the verbs we have taken into account refer to the Bloom's Taxonomy (Bloom et al. 1956; Churches 2009) and are related to the cognitive processes that are involved by the specific learning model. We have exploited them with the aim of defining learning goals. They can be found in the property page when a new learning object is created and some examples are: *remembering*, *classifying*, *describing*, *listing*, *comparing*, *planning*, *designing*. A complete list of such verbs can be found in (Salomoni et al. 2012).

According to the author's selection, BEAT can compose a lesson with one or more structure templates, which are based on the following learning models (Guerra 2006):

- *Knowledge-based model* It aims to promote self-learning to acquire knowledge base about topics that have been treated. It applies learning objectives which are mainly specific, precise, explicit and so predefined, by referring to the reproductive type. This model involves cognitive processes such as: remembering, classifying, listing, executing and retrieving. In this model, resources and content can refer to a specific part of a discipline or to a process/competence facilitated by examples or by hands-on exercises. Didactical activities are linear and sequential, such as: listen and repeat, apply the procedure, exercise the competence. This model can exploit communication tools, such as e-mails (to support each user during the understanding process), video conferencing and virtual classroom (to involve as many students), online repository (to facilitate users in sharing, searching and updating of learning resources and content). In this model, the teacher can organize and manage knowledge to be transmitted and can propose learning retrieval together with other learning content and resources, also by means of different media. Learning retrieval activities are addressed to single learners or to small group of learners. Finally, in this model, monitoring and evaluation activities are supported by close-ended questions and by structured questions. They are mainly individual and the most commonly used are: true or false, multiple choices, cloze, matching question, etc.
- *Meta-competency-based model* It emphasizes the logic of a constructivist approach to knowledge construction. Such a model moves from the perspective of metacognition and development of knowledge and skills which encourages the systematic use of investigation tools (attitudes, methods, techniques) both at individual and at group level. This supports the conceptualization, the generalization, the transferability of knowledge artefacts and methods used to produce them. In this model learning objects are general and specific, but they are not completely defined. In this case, the main involved cognitive processes are related to analysis, synthesis and evaluation. In this model, the resources and content are designed to promote learners' autonomy in broadening their knowledge and their troubleshooting abilities. In particular, the resources could be: hypermedia, text, exercises and open problems and tools, i.e. research algorithms, best practices, repertoires, etc. Main provided activities can be case studying, problems solving, simulations, etc. This model can exploit communi-

cation tools, such as forums (to enhance the dialog among users, starting discussion, carrying on specific or general topics), wikis (to promote cooperative and asynchronous or collaborative and synchronous writing sessions among participants), blogs (to support the user during the reflection process), chats (to support or promote the simultaneous interaction among users) and online repository (to enhance sharing processes among users, while collecting learning artefacts). In this model, the teacher can be intended as a facilitator, who provides training and motivational support to learners, and/or as a testimonial, who offers a model to follow, staking him/herself and collaborating with the group. Finally, in this model formative and summative evaluations are supported by: semi-structured surveys (addressed to individual learners and groups of learners), close-ended questions (to reach reproductive learning objectives) and open-ended questions (to evaluate the learners' commitment, creativity, etc.).

In the context of providing didactical materials and learning activities related to the topic of resilience management, these models are the most suitable ones and cover the most common learning and teaching conditions.

Case description

This section is devoted to present a case study of BEAT at work, in the context of offering didactical activities to support the learning and the teaching of Resilience Management-related topics. The case has been developed on the basis of the BEAT version we have personalized for the RESINT project. LF and LG have been involved in the design of the authoring tool from a pedagogical point of view, SM and PS have designed the platform and the personalization from a technical point of view, and SO has made the development and the personalization on the open source code of AContent. The case here presented is based on the creation of two different kind of digital content: textual and multimedia ones.

The presented authoring tool is an open source software, licensed under the terms of the GNU General Public License (GPL). It is a free software, based on an AMP (Apache MySQL PHP) architecture, which can be freely modified and made available to the community.

A BEAT use case

Here we describe how a learning object author can create a learning object by means of BEAT, with the aim of providing learners with textual and video content. The learning object the author is going to create is simple and does not require interaction among learners and teachers. The author is a BEAT user and is already logged to the BEAT platform. First of all, it is necessary to separate the learning object creation in two parts:

1. Defining the learning object structure (which is composed by folders and pages).
2. Filling all the created pages with the content, by means of the proper templates and the themes.

Figure 1 shows the home page of BEAT for the RESINT project. Once the author is logged, in order to create a new learning object, he/she can click on the "Create Learning Object" link.

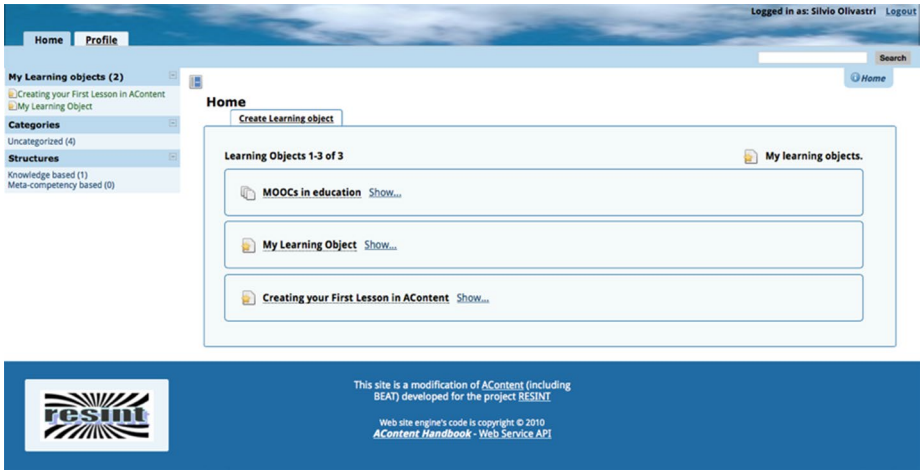

Fig. 1 RESINT BEAT home page

The "Create Learning Object" tool is activated and the author can import an already existing learning object by uploading it from his/her PC or by typing the corresponding URL (see Fig. 2). The import will be successful if the learning object is compliant with the most common e-learning standards Content Package (IMS Content Packaging Specification 2007) or Common Cartridge (IMS Common Cartridge Specification 2013).

Once the author has defined the learning object title and description (as a summary of its content), it is possible to manually create a specific structure, or to exploit the already existing ones: the knowledge-based model structure and the meta-competency-based model structure (as described in the previous subsection). Our author aims to create a simple learning object, which involves remembering, classifying, listing, executing and retrieving as cognitive processes, hence the knowledge-based model structure is the most suitable one. The author can choose "Structure" and then "Select one structure" and finally "Knowledge based" (as shown in Fig. 3).

The learning object structure has been automatically created by BEAT and it is navigable and visible on the learning object outline menu (on the left side of the BEAT interface, as shown in Fig. 4). It is now necessary to add goals, content and activities pages in the folders "Learning objectives", "Activity" and "Self-Assessment".

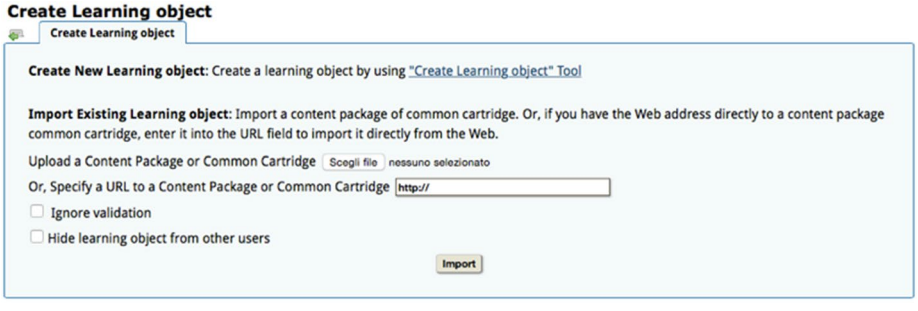

Fig. 2 The "create learning object" tool

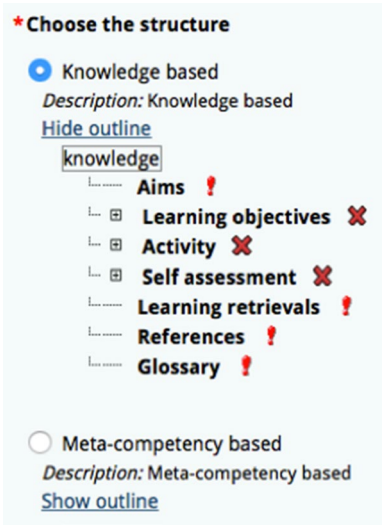

Fig. 3 Selecting the knowledge-based structure

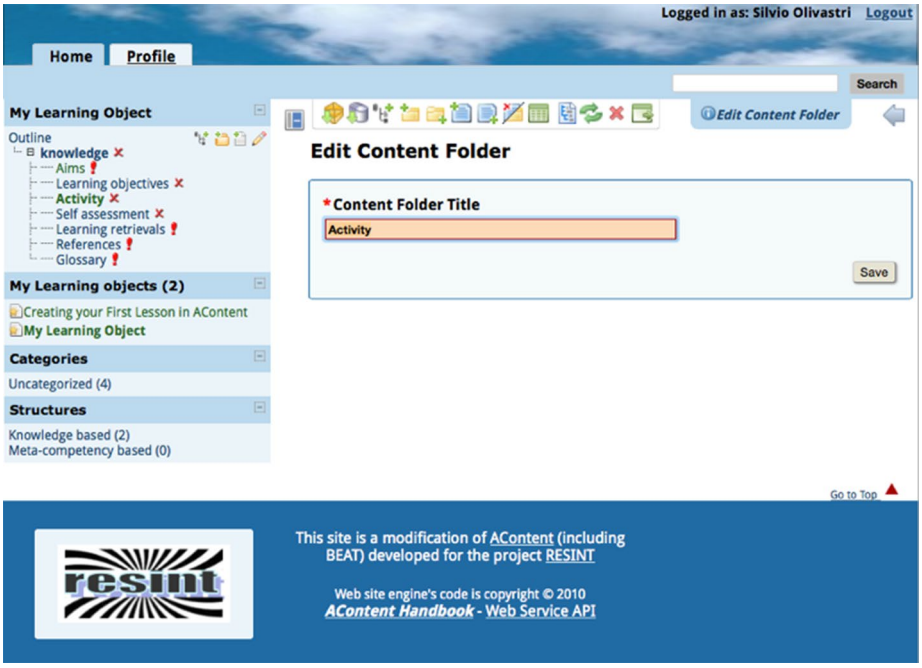

Fig. 4 Edit content folder

Since the author aims to create a learning object which offers learners textual and video content, he/she should add two new pages in the "Activity folder": "Read text" and "Watch Video". It is possible to complete this task by clicking on the "Activity" link in the Outline menu, and then by clicking on the "New page" icon in the toolbar menu (see Figs. 4, 5, "f" icon). Hence it is necessary to add the page title ("Read Text") and then to save the page (as shown in Fig. 6). The actual page content will be created in a second phase as detailed in the following.

Fig. 5 Toolbar menu

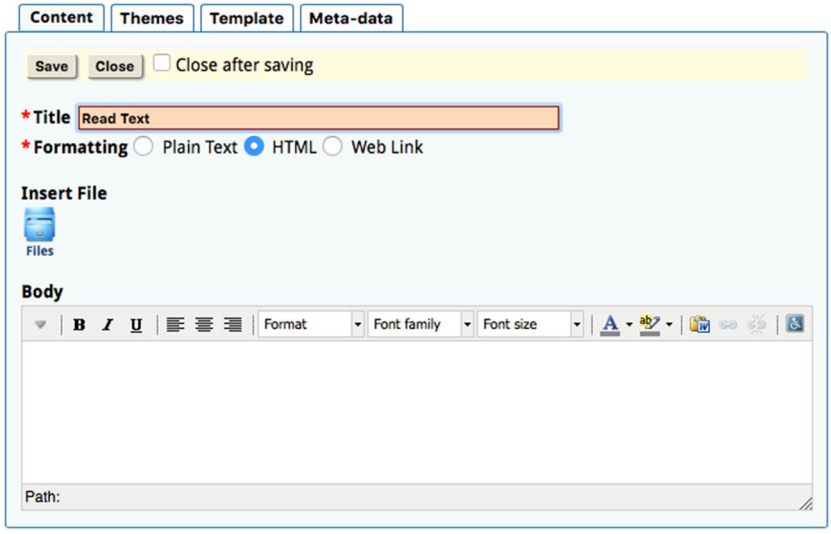

Fig. 6 Saving the new page

In a similar way, the author can create two new pages in the "Learning Objectives" folder (entitled "ObjectiveA" and "ObjectiveB") and a new "Questions" page in the "Self-assessment" folder. The resulting learning object outline is depicted in Fig. 7.

By means of BEAT, the e-learning content authors can add, modify and delete content pages and/or folders by using the toolbar menu functionalities. Different tools can be found in such a menu, since it is related to the context, hence available tools are different according to the specific selected page or folder. The main available tools are those ones which can be activated by means of the toolbar icons depicted in Fig. 5:

(a) Exporting the related learning object as an IMS Content Package compliant packet.
(b) Exporting the related learning object as an IMS Common Cartridge compliant packet.
(c) Creating a new folder, with the same level of the element selected in the outline menu.
(d) Creating a new sub-folder, with a lower level of the element selected in the outline menu.
(e) Creating a new page, with the same level of the element selected in the outline menu.
(f) Creating a new page, with a lower level of the element selected in the outline menu.
(g) Deleting the page or folder selected in the outline menu.
(h) Deleting the whole learning object.
(i) Editing and modifying the selected page.

Fig. 7 Learning object outline

Once the author has created the learning object structure, it is possible to complete it, by filling the pages with the proper content. Our author aim to create a page with the textual content which should be composed by a header (with the RESINT project logo), a textual content composed by a list and some paragraphs enriched by a digital image. Hence, after selecting the "Read Text" page on the outline menu on the left, the author can choose the "Editing" tool (the "*i*" item on the previous list, shown in Fig. 5). Then, by means of the editing window (similar to the one depicted in Fig. 6), the author can edit the content, by inserting the new textual list and paragraphs. Thanks to the layout and the page template, the author can set how the page will be structured and shown to learners. Such templates can be set by clicking on the "Template" link and the Template System will be shown to the author (see Fig. 8). Such a functionality lets the author choose the page template. Once a layout template has been set, then it will be applied to the page content (see Fig. 9).

Now the author can edit and complete the content page, by creating the page the learner will exploit by means of the Learning Content Management System with the related learning activity.

By selecting the "Theme" functionality, the author can apply a layout template to the page (by clicking on the "Apply theme to page" button) or to the whole learning object (by clicking on the "Apply theme to learning object"). The default layout template is the RESINT project one, but the author's creativity is not limited in this sense, in fact he/she can choose among different ones (as shown in Fig. 10) or can create a new layout template.

The same page with the same content is shown in Figs. 11 and 12. Figure 11 depicts the page content without any layout template, while Fig. 12 depicts the same page where the RESINT project layout template has been applied. In this last part of the content page creation, it is really useful to assign some keywords to the page, related to its content, with the aim of facilitate the learning object research within RESINT BEAT. In the

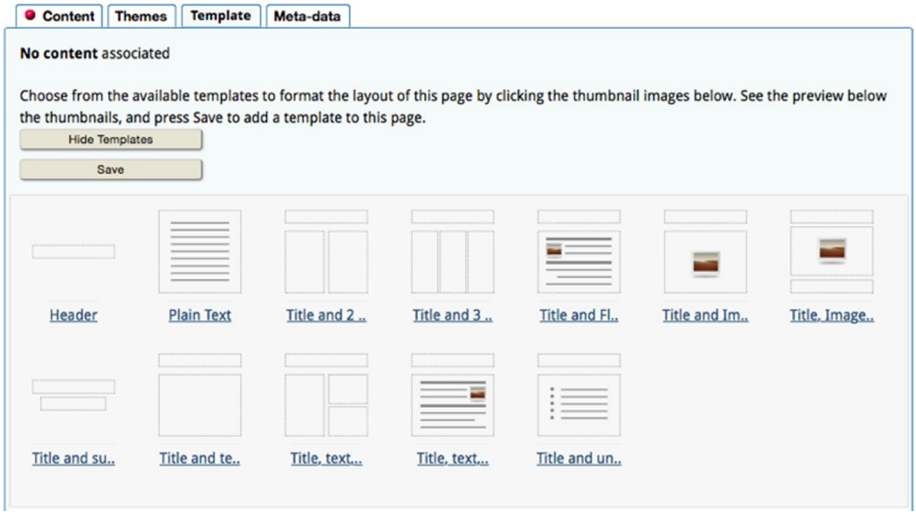

Fig. 8 Page template configuration

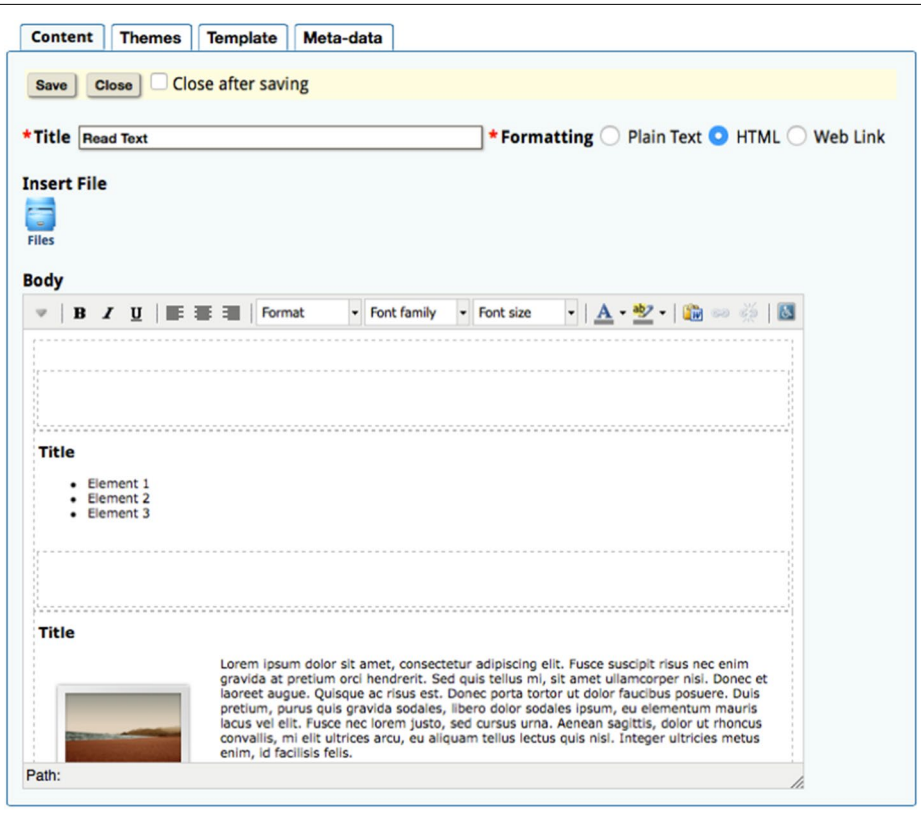

Fig. 9 Page template applied to a page content

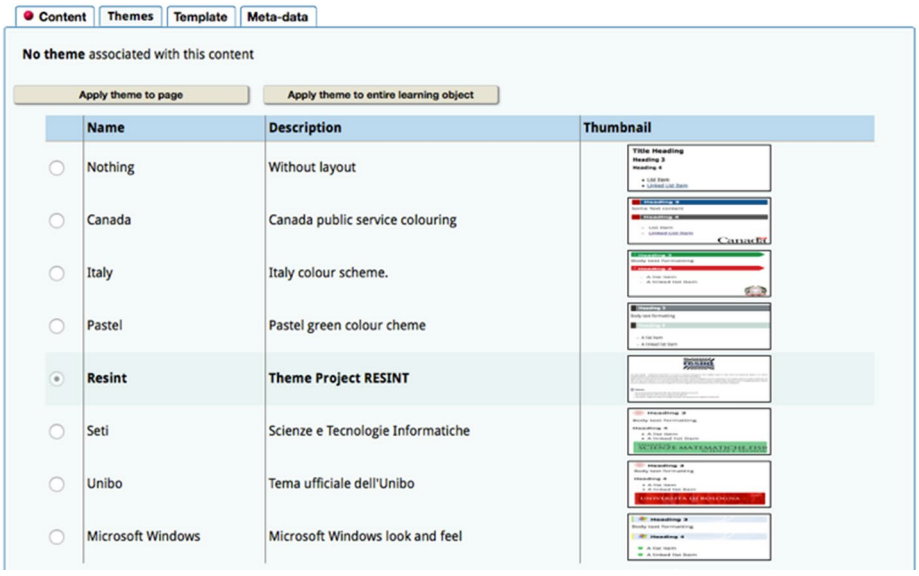

Fig. 10 Layout template configuration

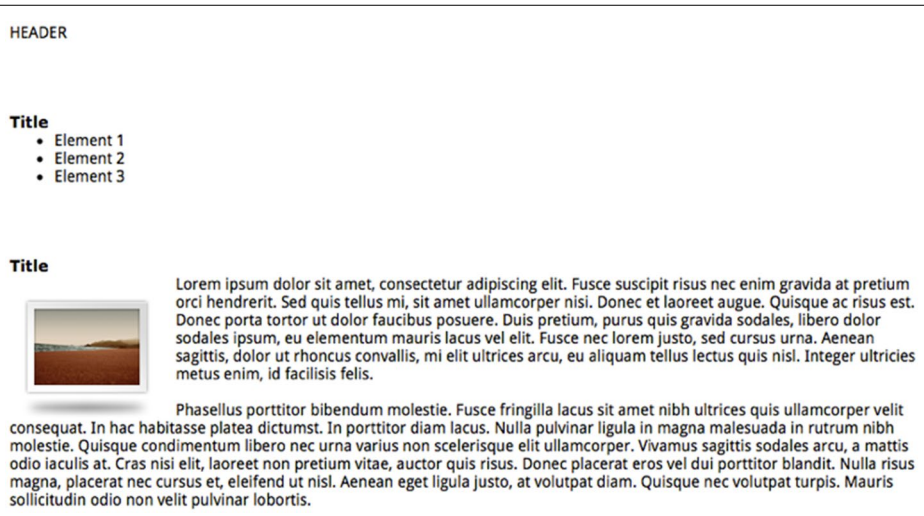

Fig. 11 A screenshot of a content page without any template applied

Meta-data functionality, it is possible to set and save such an information. Finally, Fig. 13 shows a page with a video content.

Discussion and evaluation

The use of e-learning is common and successful in several contexts and institutions all over the world. Benefits (both in terms of costs and effectiveness) of e-learning are well known and confirmed by several works (Fenu and Picconi 2010; Pittard 2004; Wilson and Wilson 2007). Starting from 2008, the increasing of online presence and open learning opportunities have create the basis of the new e-learning phenomenon: the development and diffusion of MOOCs (Guerra and Ferrari 2015). Customized and adequate

Fig. 12 A screenshot of a content page where the RESINT project template has been applied

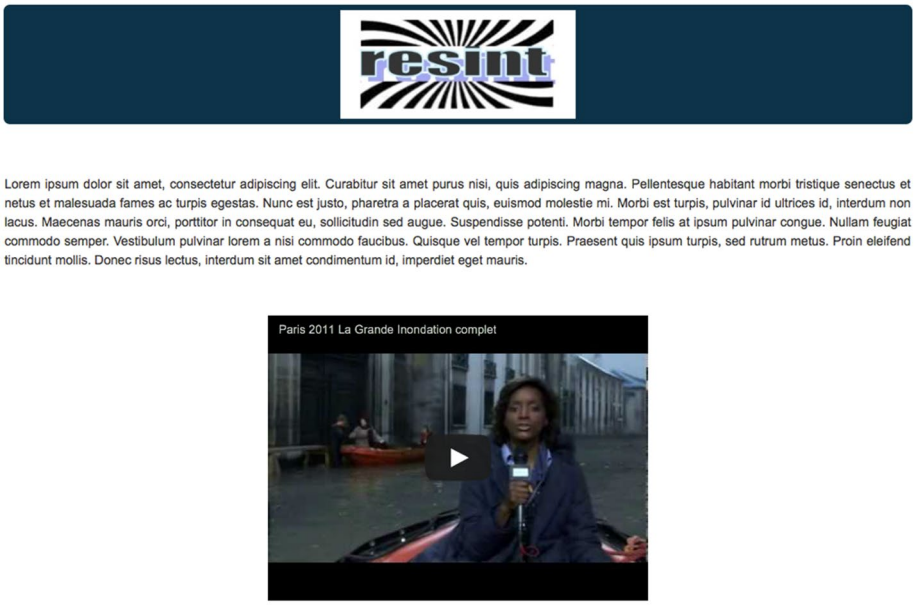

Fig. 13 A screenshot of a page with a video content

tools are needed so as to support the e-learning authors in creating didactical and open materials and to support tutors in involving learners in interactive activities.

In our case study, we have customized and developed a specific authoring tool to create open and standardized didactical materials. We have exploited an already existing open source software, by adapting and improving it, according to the needs of the RESINT project. Our aim is to offer an adequate tool to the project partners, so as to

support them in creating e-learning content and activities related to resilience management topics.

On the one hand, the use of a unique tool for all these authors, can be intended as a limitation of their creativity, forcing them in using a tool which is different from the one they traditionally exploit. On the other hand, the customization we have applied aims to overcome these limitations, since different learning object structures (supporting the author's creativity) and templates (mimicking the most commonly used personal productivity software) are provided. Moreover, BEAT has been designed and developed to be cross-browsed: this means that any content authors can fully exploit it by means of any browser (Chrome, Firefox, Internet Explorer, etc.).

In the RESINT project, an initial and short training for e-learning authors (coming from the different partners) is expected, as well as an online support whenever necessary. These, together with the adapted interface and the wizard features, would support the authors in acquiring the related skills to exploit BEAT.

From a technical point of view, the technologies at the basis of BEAT are open source and well known. Any institution could adopt it: the requirements are a Web server compliant with the AMP architecture and a system administrator confident with such an architecture.

Conclusions

This paper present the customization of an e-learning authoring tool, made within the RESINT project, with the aim of supporting learning objects authors while they create, edit and manage interactive and open e-learning content and activities. Such a tool, called BEAT, is still under development. In particular, the mechanisms which enable the creation and the distribution of Open Educational Resources (based on a three-layer template architecture and on some wizards) are completed and a use case is shown in the paper. Those functionalities devoted to let the authors exploit virtual and augmented reality technologies in the e-learning content and activities creation and management are still under development. We have also customized a Moodle instance for the RESINT project and we are currently including and extending augment and virtual reality-based functionalities so as to equip learners with more interactive content and activities in the context of resilience management-related topics.

Abbreviations

BEAT: Bologna e-learning authoring tool; CSS: cascading style sheets; GNU: GNU's not unix; GPL: general public license; GUIs: graphical user interfaces; HE: higher education; HTML: hypertext markup language; AMP: apache MySQL PHP; LCMS: learning content management systems; MOOCs: massive online open courses; OERs: open educational resources; RESINT: collaborative reformation of curricula on resilience management with intelligent systems in open source and augmented reality.

Authors' contributions

This paper is fully shared by the five authors. LG and LF carried out the pedagogical design of BEAT, PS and SM the technological one and SO the development and implementation of the case study. All authors read and approved the final manuscript.

Authors' information

LF is PhD student at Department of Education Sciences, University of Bologna. He has been involved in several national and European research projects, among which Learning4All and Classi 2.0, on relevant uses of technology in education. Research interests: relationships between new technology and learning, with a special focus on inclusive education.
LG is Full Professor of Education and Technology at Department of Education Sciences (EDU) University of Bologna, Director of the EDU Department since 2012 and Faculty Dean from 2006 to 2012. He coordinates several international projects funded by EU. Since 2009, project manager for the international cooperation project—"Scuola inclusiva in El

Salvador". SM is an assistant professor of Computer Science at the Department of Computer Science and Engineering of the University of Bologna. She has been involved in many national and international projects and she has been a visiting researcher at the University of Toronto (Ontario, Canada) in 2008. Her research interests include: Multimodal Interaction, E-learning, Content Transcoding and Adaptation, User Profiling. SO is a graduate student at the Master Degree in Computer Science and Engineering. In 2014, he received the Italian Laurea Degree in Computer Science from the University of Bologna (in Cesena). He is collaborating with the School of Economics, Management and Statistics (University of Bologna) within the RESINT Project thanks to a grant related to the development and customization of e-learning tools. PS is an Associate Professor of Computer Science at the Department of Computer Science and Engineering of the University of Bologna. She has been involved in many national and international projects and she has been a visiting researcher at UCLA (California, USA) in 2003, 2010 and 2012. Her research interests include: Design and implementation of Distributed Multimedia Systems, Design and implementation of E-learning Environments, Accessibility, Content Transcoding and Adaptation.

Author details
[1] Department of Education, University of Bologna, Via Filippo Re, 6, 40126 Bologna, BO, Italy. [2] Department of Computer Science and Engineering, University of Bologna, Via Filippo Re, 6, 40126 Bologna, BO, Italy. [3] Forlì School of Economics, Management and Statistics, University of Bologna, Piazzale della Vittoria, 15, 47121 Forlì, FC, Italy.

Acknowledgements
We would like to show our gratitude to Catia Prandi for sharing her know-how about the development of AContent and BEAT authoring tools.

Competing interests
The authors declare that they have no competing interests.

Received: 16 June 2015 Accepted: 10 October 2015
Published online: 23 November 2015

References

Aust RJ and Meyen EL (2005) The design and development of a scalable e-learning authoring system. In: Web Based Education Conference, 2005, International Association of Science and Technology for Development (IASTED), Grindelwald, Switzerland, pp 225–229
Bertin GM (1968) Educazione alla ragione. Armando editore, Roma
Bloom BS, Engelhart MD, Furst EJ, Hill WH, Krathwohl DR (1956) Taxonomy of educational objectives: the classification of educational goals. Handbook I: cognitive domain. David McKay, New York
Boni M, Cenni S, Mirri S, Muratori LA, Salomoni P (2006) Automatically producing IMS access for all metadata. In: Proceedings of the international cross-disciplinary workshop on web accessibility—15th International World Wide Web Conference (WWW 2006), Edinburgh (Scotland, UK), ACM Press. 2006, pp 92–97
Chiappe A, Laverde N, Martinez Silva J (2015) Literature and practice: a critical review of MOOCs. Comunicar Media Educ Res J e-ISSN XXII(4): 1988–3293
Churches A (2009) Bloom's Digital Taxonomy. Educational origami, http://edorigami.wikispaces.com/Bloom%27s+Digital+Taxonomy. Accessed 15 April 2015
IMS Global Learning Consortium (2007) IMS Content Packaging Specification. Retrieved: May 2015, from: http://www.imsglobal.org/content/packaging/
IMS Global Learning Consortium (2013) IMS Common Cartridge Specification. Retrieved: May 2015, from: http://www.imsglobal.org/cc/index.html
Di Iorio A, Feliziani AA, Mirri S, Salomoni P, Vitali F (2006) Automatically Producing Accessible Learning Objects. J Educ Technol Soc 9(4):3–16
Di Iorio A, Feliziani AA, Mirri S, Salomoni P, Vitali F (2008) Fighting technical complexity in authoring e-learning material. In: ICALT, 2008, IEEE International Conference on Advanced Learning Technologies, Santander, Cantabria (Spain), pp 440–442
Fenu G, Picconi M (2010) A cost-benefit comparison of e-learning solutions. Int J Inform Stud 2(1):51–59
Ferrari L, Traina I (2013) The OERTEST Project: creating political conditions for effective exchange of OER in higher education. J e-Learn Knowl Soc 9(1):23–35. ISSN: 1826-6223, e-ISSN:1971-8829
Ferretti S, Mirri S, Muratori LA, Roccetti M, Salomoni P (2008) Cooperative multimedia management for participative learning: a case study, new review of hypermedia and multimedia. Taylor & Francis, Vol. 14, No. 2, pp 177–197
Guerra L (2006) The didactic development of learning objects. Ricerche di Pedagogia e Didattica. J Theor Res Edu [S.l.] 1. doi:10.6092/issn.1970-2221/1473
Guerra L (2010) Tecnologie dell'educazione e innovazione didattica. Edizioni Junior, Bergamo
Guerra L, Ferrari L (2015) MOOC: Massimizzare le Opportunità dell'Online Collettivo, DIDAMATICA 2015. ISBN 978-88-98091-38-6 (in press)
Guerra L, Fabbri M, Maeran G (2008) A problematic teaching model for the implementation of e-learning formative pathways. In: Knowledge Construction in E-learning Context, TRIER, Università di Trier, 2008, pp 1–5
Guralnick DA, Levy C (2009) Enabling effective e-learning creation on a large scale: special-purpose authoring tools. Int J Emerg Technol Learn (iJET) 4(S3):23–27
Hesse S, Gumhold S (2011) Web based interactive 3D learning objects for Learning Management Systems. In 2nd International Conference on Education, Training and Informatics (2011). Vortrag. Orlando
Hui S, Liu J (2005) An online template-based authoring system for e-learning. Lect Notes Comput Sci 3583:38–48

Lucke U, Zender R (2011) 3D interactions between virtual worlds and real life in an e-learning community. Adv Human Comp Interact 2011:6
Miller GE (2011) ICDE's role in ensuring quality in international inter-institutional collaborations. Retrieved April, 2015, from: http://www.icde.org/?module=Files;action=File.getFile;ID=1775
Mirri S, Salomoni P, Roccetti M, Gay GR (2011) Beyond standards: unleashing accessibility on a learning content management system, Springer Transactions on Edutainment, Springer, Vol. V, LNCS 6530, pp 5–49
Pittard V (2004) Evidence for e-learning policy. Technol Pedag Educ 13(2):181–194
Salomoni P, Guerra L, Prandi C, Ferrari L, Mirri S, Lovece S (2012) BEAT: an AContent extension to support authors in developing learning pathways In: Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2012 (ELEARN 2012), Montreal (Quebec, Canada), 9th October 2012. ISBN: ISBN 1-880094-98-3, Chesapeake: AACE (UNITED STATES), pp 371–378
Trelease RB, Nieder GL (2013) Transforming clinical imaging and 3D data for virtual reality learning objects: HTML5 and mobile devices implementation. Anatom Sci Educ 6(4):263–270
Wilson R, Wilson M (2007) Cost-Benefit Analysis of E-Learning. Int J Inform Sci Comp 1(1)