A METHODOLOGY TO BUILD E-LEARNING MULTIMEDIA RESOURCES

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Abstract: In this paper, we present a methodology to develop e-learning resources. It focuses on the resources creation, so it can be integrated in a general methodology for big e-learning projects or it can be used in small e-learning projects in which the main task is the content creation. The methodology has been conceived by taking into account several crucial issues, such as e-learning standards, accessibility, and easy of its application. A case study is also described to show the effectiveness of the proposal.

1 INTRODUCTION

The creation of e-learning resources is a very challenging and complex process, which involves several professionals and requires very different skills and competences. Thus, there is the need of methodologies and tools that simplify all the phases related to e-learning resources creation. Generally, the process can be divided in several phases, such as the business planning definition, the technical staff creation, the instructional goal definition, the learner and content analysis, the content authoring and so on. Some tasks are related to the e-learning resource building while others are related to the whole project management or to the instructional features. We concentrate our efforts on e-learning resources creation. The approach proposed puts strong emphasis on re-use and interoperability, which are crucial aspects for an effective and cost-effective development of e-learning materials. As a matter of fact, many organizations are defining standards for e-learning. The aim of these standards is to allow us to share on-line knowledge content objects and to ensure their interoperability on all the Learning Management Systems.

Another issue that has been considered by the proposed methodology is web accessibility. Indeed, e-learning resources have no to be only rich, engaging, instructive and standard compliant, they have to be also accessible. With the web development "web accessibility" has become a central topic since e-learning resources should be accessible by everyone, regardless of disabilities. Many authoring tools vendors define methodologies for LOs authoring but they are often suitable only for their tools. Our efforts were addressed to the definition of a general but simple methodology to build e-learning resources. It can be applied with any software to produce any kind of resource. It focuses only on the resources creation so it can be integrated in a general methodology for big e-learning projects or it can be used in small e-learning projects in which the main task is the content creation.

In section 2 we introduce e-learning standards and in section 3 the accessibility guidelines. In section 4 it is presented the methodology while section 5 is devoted to illustrate an application example. Some final remarks conclude the paper.

2 E-LEARNING STANDARDS

Web technologies and e-learning had a very fast evolution in the last decade: many Learning Management Systems (LMS) have been realized using heterogeneous technologies and architectures. E-learning resources often didn't run under all the systems because held back by proprietary standards. Moreover, with the increasing availability of on-line lessons, courses, and general e-learning resources, the discovery and re-use of knowledge objects have become very important. Standardization is need to allow us to share knowledge objects and ensure their interoperability on all the Standard Compliant LMSs. The use of standards for the creation of e-learning resources is the prerequisite to create general, well-described, usable LOs.

Organizations like IEEE's LTSC (IEEE LTSC), IMS Project (IMS Project), Aviation Industry's AICC, Advanced Distributed Learning (ADL)

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initiative (ADL) are contributing to this standardization process. They have defined the concept of Learning Object (LO) as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. For a LO specification Metadata have been defined, which are classified into eight categories: General (includes context independent features such as title, description, etc.), Lifecycle (includes version, author, etc.), MetaMetaData (information about metadata), Technical (includes file format, size, etc.), Educational (educational features), Rights Management, Relation (features of the resource in relation to other resources) and Annotation (comment on the educational use of the resource). Metadata enable content developers and instructional designers to effectively search and retrieve didactic contents in order to assemble them to create new contents. Moreover learners can enhance their knowledge looking for contents in LO repositories.

ADL Sharable Content Object Reference Model (SCORM) is the document delivered by the US department of Defence, which organizes and collects the specifications produced by others groups (AICC, IMS, IEEE and others). The SCORM is a collection of specifications adapted from multiple sources to provide a comprehensive suite of e-learning capabilities that enable interoperability, accessibility and reusability of web-based learning content. SCORM describes various components used in a learning experience, provides information on applying meta-data to such components to enable search and discovery, describes how to package those components for exchange from system to system and how to define the sequencing rules for the components. Moreover a part of SCORM describes the LMS requirements for managing the run-time environment (i.e. content launch process, communication between content and LMSs and standardized data model elements used for passing information about the learner). The production of SCORM compliant learning resources assures their diffusion, usability, and quality.

3 ACCESSIBILITY GUIDELINES

Another aspect to consider when building e-learning resources is web accessibility. Web accessibility means access to the Web by everyone, regardless of disability. It includes web sites and applications that people with disabilities can perceive, understand, navigate, and interact with. An accessible web design contributes to better design for all the users. Moreover many countries have a well-defined policy relating to web accessibility in particular for institutional sites. The World Wide Web Consortium (W3C) is an international, vendor-neutral consortium, that promotes evolution, interoperability and universality of the web. It released the Web Content Accessibility Guidelines (WCAG 1.0) document, which contains some guidelines and important rules to make a web resource accessible. In the following we provide a brief outline of some of these rules. For a more complete discussion we refer to (W3C). For people with visual or hearing disabilities it is important to provide equivalent alternatives to auditory and visual content. Thus, it is essential to associate descriptions to figures and tables and to describe graphics. This description can be used also from assistive software for people with disabilities (i.e. screen readers). The web-resource cannot be based on colour alone and text and graphics have to be understandable when viewed without colour. Natural language use has to be clarified and it is important to use mark-up that facilitates pronunciation or interpretation of abbreviated or foreign text. Finally, if new technologies are used in the resource, it must be accessible even when newer technologies are not supported or are turned off. Some recommendations are not strictly related to accessibility but are very important for any kind of web resource. For example, the design for device-independence, the use of features that enable activation of page elements via a variety of input devices and the presence of user control for time-sensitive contents (i.e. moving, blinking, scrolling, or auto-updating objects). It is important also to provide context and orientation information, clear navigation mechanisms and to create clear and simple documents. If it is not possible to follow one or more accessibility guidelines the author must realize an alternative accessible version of the content.

4 THE METHODOLOGY

Many vendors develop methodologies for the creation of e-learning resources. Usually, they are not very general and apply well only when used with a particular software. On the other hand, some general methodologies are too abstract and people not-experienced with e-learning projects are often disoriented.

In this paper, we present a simple methodology in which concrete topics related to the resources development are emphasized. We do not consider issues like the business plan definition or staff creation. We address our efforts to multimedia web resource creation. The creation process starts from

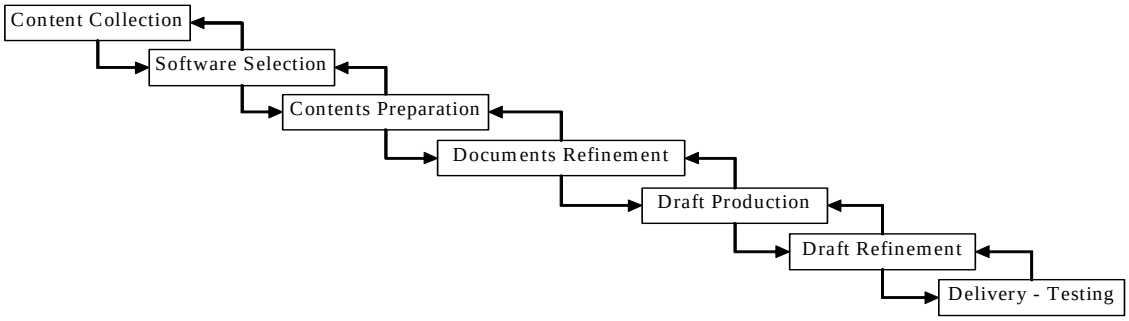

Figure 1: E-learning multimedia resource development methodology.

the collection and preparation of contents and finishes with the e-learning resource delivery (see Fig. 1). It is worth noting that the first step in the e-learning resource creation is the definition of what we want to realize: we must delineate an initial idea that can be refined later. It is important to define the scope of our work to keep in mind our objective in all the creation process phases. To this aim, we should consider the available economical resources and user target. In this paper we do not taking into account issues concerning with learner analysis, context analysis, instructional analysis, business plan definition and so on. So, the methodology starts with content collection.

Phase 1: Content Collection

In the first phase all the didactic material must be collected. Instructional designers and/or content experts must define the set of documents need to create the e-learning resources. Some documents can be available in a digital format (i.e. presentations or text documents) while others can be available in other formats, such as books. When the available material is inadequate to realize rich multimedia objects it is necessary to develop customized documents. These documents are realized from the content expert that is supported by a technical staff. To minimize the work requested to the content expert, such additional material is often realized during the normal content expert activities.

Let us consider the following example that will be used in the rest of the paper. We want realize an on-line lesson in which learners can view the teacher video, which is synchronized with a presentation composed by a set of slides and learners can navigate the lesson via a Table of Contents (TOC). In the content collection phase, we should realize the teacher video. It can be produced in a recording studio, where there are perfect audio/brightness conditions, to obtain a high quality video. Obviously, we must pay the teacher to realize this lesson and he/she has to find the time to do it. If we have economical constraints or if the teacher has not time it is impossible to realize such a video. Actually learner needs to listen the lesson in a clear way but he/she does not need a high quality teacher image. Thus, if the teacher instructs in a university the video can be recorded during the normal classroom lesson. Video quality will not be the same as in a recording studio, but, if we use a good microphone for audio, we can obtain a video that is good enough for the on-line lesson realization.

In this phase we should collect or realize all the documents necessary for the e-learning resource trying to reduce the content expert cost.

Phase 2: Software Selection

Once the didactic content is available we should create an e-learning resource. The software selection to build e-learning resources is a delicate activity. First of all, we need tools to digitalize, compress, modify, and improve the collected documents. Later, we need the software to assemble these documents to obtain an e-learning resource. During the software selection activity it is important to consider the typology of e-learning resource that we want to realize, together with e-learning standards and accessibility guidelines. Moreover, we should consider the skills requested to use the selected software and the software flexibility. In general, we have two main alternatives. We can use simple tools that have a limited flexibility or complicated tools which are more flexible. As a matter of fact, if we use a high level programming language, such as .NET or Java, we have infinite options. On the other hand, we need a staff of programmers and analysts to create a lesson. We can also realize the lesson using a simple authoring software. Obviously, we are limited by the software's features, but also a developer with a low technical skill can produce the lesson. Moreover, he/she can realize infinite lessons with the same technique.

In some cases, it is impossible to obtain an e-learning resource with defined features with a given software. In this case it may be convenient to obtain a similar e-learning resource using a simple authoring tool and then to refine the resource to include some features. As an example, let us

suppose to have a software that, using a simple wizard, enables the user to create an on-line lesson composed by a set of HTML files (that can include some interactive objects). This lesson contains a set of images but the software does not associate a complete description to each image. Thus it is not accessible. However, a user with basic skills of HTML can add image descriptions before delivering the lesson. Thus, it is better to use a simple authoring tool and to refine later the produced objects than to use complicated technologies.

Phase 3: Content Preparation

Some contents should be refined or translated and all the documents should be converted in a digital format. In the digitalization phase it might be necessary to make some choices about file formats or compression ratio. Once documents have been collected and digitalized we can use them many times for various purposes. Re-use in e-learning is a relevant topic because costs related to content development are very high.

Let us consider some examples. Let us suppose that we have a presentation in Portable Document Format (PDF) and that we need to convert it in Power Point Format (PPT). We also suppose that we need only the 80% of the presentation slides to build our e-learning resource. It is better to translate and transform all the slides and have a complete presentation for future use. In fact, we can deliver such presentation on a web site, present it in a classroom lesson or include it in an e-learning resource. When we start a digitalization, conversion, translation or preparation process it is better to work on the whole document. We will have a little greater cost but we will produce a re-usable resource. Moreover we often realize documents preparation using automatic tools. Suppose to have a video in an analogical format and to need it in a digital format. We suppose also that we need a small sized and low quality video to deliver it on the web. We could use a software that compresses and resizes the video obtaining a relatively small file. On the other side, if in the future we need to deliver such video on dvd with a high quality we could not re-use the same file and we need to repeat all the work. Thus it is better to acquire the analogical video with the best available quality and with lossy compression algorithm.

It is important to choose diffused format and lossy compression algorithm for audio, video and image. The use of well-supported file-format and audio/video standards assures that we can use the obtained files with all the software. Moreover, it is important to develop knowledge objects that can be re-used even if the cost is higher than produce customized objects.

Phase 4: Document Refinement

We must customize and refine the obtained documents to effectively use them to build the e-learning resource. If we consider again the on-line lesson example, we should compress and resize the video because for the on-line lesson we need only a small sized video with a low resolution. We can also improve audio quality. Moreover, if the selected software accepts only some kind of file formats we must convert all the documents in the supported formats.

Phase 5: Draft Production

We create a draft of the e-learning resource in order to submit it to a group of learners and collect feedbacks to improve it. It is not necessary to be standards compliant and to follow all accessibility guidelines because we'll refine the draft later. Anyway we must consider some elementary rules such as differentiate structure and contents, combine colour, describe acronyms, use CSS and well-supported HTML tags.

Phase 6: Draft Refinement

Draft is refined to obtain the final e-learning resource using some tool or manually. Let us consider again the on-line lesson example. We can add an introductive page even if the tool used for the draft production did not enable us to do it. We must also check that the e-learning resource is standard compliant and accessible and possibly modify it in order to satisfy such requirements. The ADL Organization delivers the Test Suite Software to check if an e-learning resource is SCORM Compliant. Using it we can execute the Sharable Content Object (SCO) RTE Conformance Test, the Meta-data Conformance Test and the Content Package Conformance Test. The purpose of ADL SCO RTE Conformance Test is to verify that the test subject is able to be launched by a known conformant LMS and supports the RTE Application Program Interface functions defined in the SCORM. The purpose of Meta-data Conformance Test is to verify that the test subject meets conformance requirements based on the meta-data section described in the SCORM. Finally, the Content Package Conformance Test verifies that the tested Content Package is conformant with the Content Aggregation Model of the SCORM. If a resource passes all the ADL tests it can be considered SCORM Compliant. If our resource is not accessible in this phase we must modify it. If it is not possible to satisfy all the accessibility guidelines we must provide an alternative accessible version of the e-learning resource.

Phase 7: Delivery and Testing

The e-learning resource has to be delivered on a server. We should also monitor its behaviour, since it is important to discover and resolve bugs. Before

delivering the resource we should write a user manual, where we explain how to use the resource and the software needed to use it. If specific software is needed such software should be free and easily available. Finally, we should write a technical manual so that a staff can repeat the e-learning resource creation process more times. In this document, we should describe in detail the development process starting from the used software, setting, and user delivery techniques.

5 A CASE STUDY

In this section we present an example of application of the methodology for the creation of on-line lessons for a university course. We wanted to give the same information as in the classroom lesson, thus, we included the teacher video and a set of slides synchronized with this video. When necessary, we integrated an additional video reporting what happened on the teacher computer. This is useful if the teacher shows to the classroom a process by using his/her computer (for example how to compile a program).

Phase 1: Content collection

For each lesson the teacher had a presentation, in PPT format or PDF. To create the on-line lessons we needed also a teacher video, that we recorded with an analogical camera during normal classroom lessons. We recorded also the teacher monitor.

Phase 2: Software Selection

We used Camtasia Studio to record the teacher monitor. To acquire and compress video we employed an external video card Hauppauge WinTV-PVR-usb2 with the related software WinTV2000 to convert analogical video in digital video. To improve audio quality, we used TmpGENC, dBpowerAMP Music Converter, Audacity and VirtualDub. To convert pdf in ppt format we used Laux Information Technology PDF2PPT. We obtained a draft of the on-line lesson using Microsoft Producer. Thesis Pro allowed us to convert on-line lessons in SCORM Compliant LOs. Finally the on-line lessons were delivered on a web server using FileZilla.

Phase 3: Material Preparation

We digitalized and compressed the teacher video using the video card Hauppauge and WinTV. We chose “dvd standard” as level of video compression, to obtain a high quality video and files in mpeg2 format.

Phase 4: Documents Refinement

To improve the audio quality we used TMPGenc that permits to demultiplex a mpeg2 file. Using the “Simple Demultiplex” functionality on the mpeg2 file we obtained a video file “video_lesson.m2v” and an audio file “audio_lesson.mp2”. To elevate the audio loudness we used Audacity, which accepts only mp3 and wav file. dBpowerAMP Music Converter converted “audio_lesson.mp2” to mp3 format, then with dBpowerAMP Music Converter we obtained again an mp2 file using a bitrate of 384 kbps. Using TmpGenc we collated together the modified audio file and the original video file. Since Microsoft Producer accepts only video having a size smaller than 1Gb, we used VirtualDub to resize the video (320x240) and to compress it using divX format and a bitrate of 500 kbps.

Phase 5: Draft Production

Microsoft Producer allows us to synchronize audio, video, slides, and images in multimedia presentations providing a set of templates with a wizard. We used the template “Professional video (240 x 180) slide and HTML resizable” to make easy the development process even for people with low technical skill. Producer permits to choose character type, colour, size, background colour, and slide background. We chose those parameters considering the graphical effect and the accessibility guidelines. Later, we associated each slide with a piece of video. Finally, in the publishing phase we chose to make two versions. The first was “light” for a person with a limited bandwidth while the second was for people with a higher bandwidth. Producer automatically sets the video compression level and quality. It creates a folder containing all the files needed (CSS, HTML, JavaScript, images, video) for the on-line lesson. Figure 2 shows an example of lesson. On the upper right area we find the teacher video with the related controls (play, pause, forward, rewind, loudness). Under the video there is a Table Of Contents to navigate the lesson and on the left there are the slides.

Phase 6: Draft Refinement

Producer allows only one video in the presentation. So to add the video showing the teacher monitor we decided to stop the lesson and to

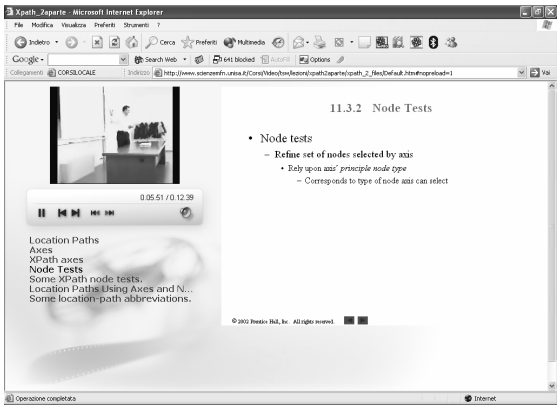

Figure 2: An on-line lesson

start a new pop-up window showing it. The on-line lesson folder created from Producer contains a JavaScript File (gogoprod.js), with all the functions to manage the user interaction with the Table of Content and to synchronize slide and video. We modified such functions to pause the on-line lesson and open a pop-up window containing another video.

We checked if the lesson produced was SCORM Compliant using the test suite software released from ADL. The SCO RTE Conformance Test had a positive result, while the Metadata Conformance Test failed since Producer does not define lesson metadata. We used Thesis Pro that creates and deploys SCORM conformant learning content. It allowed us to import the IMS_Manifest obtained from Producer and to define lesson metadata (title, type of resource, description, rights, etc.). The lesson so obtained passed all the ADL tests.

As for the accessibility guidelines, we had only two problems. The first was related to the difficult to modify the on-line lesson to provide equivalent alternatives to auditory and visual content, indeed screen reader reads text (url, controls, slides and everything is present in the page) and at the same time the learner must listen the lesson. The second problem was related to the use of some technologies that could not be supported from all the learners. We decided to produce an alternative version of the lesson in plain HTML containing slides and teacher explanation for each slide. This version is accessible.

Phase 7: Delivery and Testing

We organized the links to all the lessons in a web site. For each lesson it was inserted a table containing the lesson length, the number of slides and the lesson contents. In the same table we put the link to view the on-line lesson with 56Kb bandwidth, ADSL bandwidth, and to download the lesson. Finally, in this table there is the link to a full accessible lesson and it was included a user manual. Finally we used FileZilla to deliver the entire package on a web server. FileZilla transfers automatically in the right way ASCII file (i.e. CSS and Javascript) and binary file (images and video).

6 CONCLUSION

In the literature, several papers provide e-learning instructional strategies while we find few proposals for methodologies meant to ensure an effective authoring of e-learning resources. In (Gibson et al., 2002) many features are analyzed such as the course outline definition and the expertise staff creation and management. They use Microsoft Word to create on-line course material. Then using a macro they obtain the course page and the table of content and an xml-based document. In (Kirsch-Pinheiro et al.) it is presented a web based cooperative environment for e-learning authoring controlled by a workflow engine. The workflow defines clearly all the activities to be executed, their relationships and coordination together with the agents responsible for their execution. In (Boyle, 2003) general issues related to the authoring of dynamic, reusable LOs are discussed. In (Yacine et al., 2003) an approach to the design of a learning environment that reacts to the evolving learner model is proposed. In (SCORM) the aspects in content authoring related to the SCORM e-learning standards are emphasized.

In this paper an easy to apply methodology has been presented. It focuses on the content creation and considers e-learning standards to enable re-use and interoperability of the produced LOs. We emphasized also the accessibility of the produced e-learning resources.

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