Abstract. Distance learning course support material and multimedia content authoring, production and distribution in web, print, video and other possible formats are complex tasks that need to be addressed in a structured way in order to achieve a scalable and manageable process. Beyond that, the “authoring and production process chain” from “knowledge to content” and finally from “content to multimedia formats” has to keep in track all the basic pedagogical premises defined by the specific pedagogical project and course curriculum. This paper introduces and discusses a modeling process with structured steps and actions towards a curriculum to content and multimedia support material production. It is argued that the proposed model and structured tasks preserve the pedagogical project premises and, also, allows a scalable and manageable production process. The approach is suitable for courses involving any typical set of distance learning actors such as professors, coordinators and content creators and, in relation to the production process, making use of multiple multimedia content format distribution options.

Keywords: Curriculum, content authoring, in loco semantics, learning units

1 Introduction

Distance learning course support material and multimedia content authoring, production and distribution are complex tasks that have to be addressed by, first and foremost, professors, instructors and/or lectures, who in turn, are typically neither familiarized nor in agreement with the use of “knowledge” in a large scale production style. This aspect, as such, represents one “first challenge” to be addressed by most of the researched models and methods towards the production of course support material with multiple multimedia content formats in distance learning course scenarios [1][2][3].
Distance learning course support material creation and authoring approaches, also tend to make use of learning objects using multiple assets in different multimedia formats such as text, video (streaming, real-time, on demand, off-line or any other mix), sound files, hyperlinks, animation, pictures, simulation and many other alternatives which, fundamentally, look for the facilitation of the learning process through “ludicity” and easy to comprehend interfaces [4][5]. This perception is more frequently applicable for web-based distance learning courses, since the web, by perception, is highly interactive and easy-to-use, but may also be generalized for other distance learning course implementation alternatives in which interactions and actors mediation are not particularly based on web technologies. Multiple media interactions and ICT (Information and Communication Technologies) support are effective assets for creating “flexible courses” adaptable to different publics and implementation scenarios such as graduation, under-graduation, post-graduation, social environment and students age, among others.

This paper addresses the intrinsic need to model and implement a practical and acceptable “distance learning course multimedia support production chain”, considering the essential steps in the process production sequence. It is argued that the process should consider and starts from “knowledge to content” mapping and finally considers the generated content transposition to multimedia format production and distribution methods. A fundamental aspect that is addressed and argued as essential is the “natural insertion” of professors and instructors in a methodological approach intended to multimedia creation, production and distribution.

The proposed model should also support and facilitate “reuse” and motivates “collaboration” among distance learning content creators. Reuse in this context should be understood as the possibility to compose course support material from content units existing on different courses and on the web through any technological support provided [6].

2 Curriculum Decomposition

2.1 The “Knowledge” to “Content” to “Multimedia” to “Learning” Problem

The “Knowledge” (teacher’s asset) to “Content” (curriculum and content units) to “Multimedia” (effective course support material) to “Learning” (knowledge construction by learners) authoring, production and distribution problem is an open research and implementation issue with diverse alternatives methods being proposed and used [7][8][9][10][1].

One of the challenges involved in most of the common approaches used is how to deal with the different actors involved and, also, how to keep control and how to manage the whole process.

One possible approach to achieve these results consists in assuming the modeling for the whole production chain as follows:
First, it is necessary to define a set of rules and procedures that is capable to guarantee a curriculum to content mapping preserving the curriculum premises;

Secondly, it is necessary to adopt a modeling process focusing on multimedia formats production that is able to deal with the various actors involved, heavily based on ICT resources and capable to guarantee a scalable and manageable process.

A straight “content” to “learning” mapping approach is proposed as the basic procedure that guarantees curriculum premises by adopting a set of pedagogical and curriculum implementation principles and characteristics. The set of pedagogical and curriculum implementation principles is defined and supported by a team of professionals (Content Support Team) which, firstly, capacitates the involved actors and, secondly, provide guidelines (orientation) towards content units creation.

A workflow tool associated with a well defined and structured “creation to production” process is proposed as the basis to guarantee a scalable and manageable production line which incorporates the “knowledge” to “Content” step with a multiple and variable set of actors being involved.

In addition to the basic approaches indicated, a well defined and structured workflow approach may result in support material investment reduction and optimization while dealing with the inherent dynamics of distance learning courses.

2.2 “Content” to “Learning Units” Mapping

The dialogic-interactive intrinsic characteristics of Information and Communications Technologies (ICTs) may support a substantial revision of curriculum models for distance learning.

The so called unidirectional media which, by definition, adopt a “diffusion center” and multiple “reception points”, like printed material, radio and TV (without any retour channel), were predominantly used by distance learning courses up to now and impose a directive characteristic to these programs. In effect, these media do not support frequent and agile interactions and, as such, circumvent the didactical support material being used to their limitations in terms of storage and flexibility for distribution.

New technologies, including the web, create the possibility and support high interactive levels at low cost, are real-time and have their storage capacity considerably upgraded. These facilities allow diverse multimedia utilization for the didactical support material and a more efficient distribution method. The new “tools” which occur initially on the technological scenario, give the possibility to overcome the limits previously imposed to the distance learning courses and, as such, give the possibility to revise and adapt the principles and pedagogical practices adopted resulting in the possibility of reaching a substantial qualitative improvement to these programs.

These attributes resulting from ICTs utilization allow the adoption of pedagogical principles like constructivism, autonomy, interdisciplinary practices and collaboration, among others. On the other hand, the adoption of these pedagogical principles impose a complex and sophisticated authoring, production and distribution process and the follow-up of interdisciplinary and collaborative practical units
which, in turn, have to be expressed in terms of the content and pedagogical practices created during the course implementation process. The course implementation process as such has to guarantee:

- Permanent review and content customization;
- Diverse multimedia formats for contents presentation;
- Integration and reuse of the produced support material in order to promote, among other possibilities, the interdisciplinary practices.

In this context, “content” may continue to be produced in a “discipline-based” style which can be expressed in “units” (learning modules) (Fig. 1). The “units” should be available to all actors involved in the course creation and production process (professors, tutors, coordinators, content creators, others) in such a way that could be appropriated and reused at any time among disciplines in order to support interdisciplinary activities and practices. Also, there is an optimization process involved when cost and the production process itself are considered.

![Curriculum content mappings](image)

**Fig. 1. Curriculum content mappings**

The curriculum and didactical support material should be conceived, produced and be available in a centralized way for the learner and, based on the constructivist principle, may be decomposed on different multimedia formats in order to be used anytime according with the learner and other pedagogical actors needs. This
approach facilitates the learner’s autonomy, the interdisciplinary practices and collaboration.

Finally, the integration of contents and practices in order to assure the integrity of the formation objectives previewed in the pedagogical project and its mappings should occur on a pedagogical supervision level executed through managerial practices provided by a “content” to “multimedia” modeling.

3. “Content” to “Multimedia” Modeling

In order to achieve the goals presented in previous sections (e.g., high content adaptability, content reuse, multi-format presentation) we designed a support infrastructure, which can be both flexible and dynamic. This infrastructure is based in the workflow illustrated in Figure 2, which combines tasks performed by people (multidisciplinary distance learning actors) – developed in different stages of multimedia production (authoring, creation, revision, others) – with automated tasks performed by computers. The whole process is managed by a workflow engine.

![Workflow Diagram](image)

**Fig. 2.** Content to multimedia modeling workflow

As can be seen in the figure 2, the workflow sequence starts when an author submits content, written using a popular text-processing tool. The workflow engine
transfers this content simultaneously to a content reviewer (production style premises) and to the course coordinator responsible for the discipline’s content (curriculum and pedagogical premises). There are two kinds of “articulated” reviewers working in the workflow. First, the content reviewer responsible for the text correctness, who is followed by the style reviewer, responsible for adjust the content to the style standards. After the revisions, content is archived and also is transformed in a publishing XML format, the Docbook [11]. This format will enable to split “content” from “style”, and, as such, facilitates to transform the “content” in many multimedia presentation formats, as presented in the bottom of figure 2 and detailed in figure 3.

The content to multimedia modeling adopts a set of actions upon the micro-content unit defined by the curriculum decomposition method and assumes separate set of policies to produce multimedia artifacts as indicated in figure 3.

The policies, upon execution, generate the effective mappings from content to multimedia formats. In terms of process evaluation and implementation towards a scalable production line, this approach allows a set of managerial facilities. Having policies to support multimedia content production allows:

- The same content can be presented in various multimedia formats (e.g. web, printed, cell phone), by the separation of content from presentation aspects.
- Structured content reuse – produced digital artifacts are potentially classified, indexed and stored in a repository for further reuse.

Fig. 3. Multimedia formats creation modeling

One key aspect to be considered in this stage of the process chain is how each micro-content is represented as a digital artifact. A micro-content is a small curriculum unit, which is transformed in a content unit but, on the other hand, it can comprise a complex combination of digital artifacts. For this reason each micro-content unit is mapped to a learning object.
3.1 Multimedia Production Mappings

Nowadays, there are many devices to be used to content presentation in distance learning activities, e.g., web browsers, mobile devices, printers, MP4 players. Conventional methods of content production result in a lot of time and work to adapt the content presentation to these devices. We adopted the single-sourcing strategy in order to optimize content production in multiple formats. The main requirement considered in this strategy is that “content” must be split from “presentation format” during content creation and production. In a nutshell: one source (content) and many presentations. Single-sourcing is not a new discipline and there are many proposals in this area, specially using XML as a basis to represent the source.

Usually single-sourcing is adopted by the publishing market, which uses specialized tools and specialized authors to produce the content. In our context – as usual in distance learning scenarios – content is produced by a scattered group of non-specialized authors – professors, coordinators, others. Our experience shows that it is not possible to impose any single-sourcing specialized tool to this type of author and, therefore our challenge, in this context, is how to work in a single-sourcing approach using non-specialized tools. We will show in the next section our approach to handle this question, we call “In Loco Semantics” [12], where our authors write their content using popular text-processors (e.g., MS Office and Open Office).

3.2 In Loco Semantics

“In Loco Semantics” can be defined as a strategy developed in this proposal to produce annotations related with digital content with interoperable semantics, which follows the following principles [12]:

- In loco annotation: the annotation process occurs concomitant to content production (in loco).
- Metaphor integration: the metaphors and models adopted to annotate the content are aligned with those adopted to produce the content.
- Interoperability: the strategies of in loco annotation are designed to enable their automatic extraction from content and further conversion to open Semantic Web representation standards.

“Annotations”, in our context, will guide two parallel processes: the splitting of content from presentation format, and the automatic extraction of metadata, which will be used for classification and indexation purposes.

The first step to implement the in loco semantics is illustrated in figure 4. The authors are prepared to use text-processing styles, instead of details presentation characteristics of the text. The figure shows two examples. In the first, instead of format a title using \{font: FreestyleScript, size: 32, bold, centered\}, the author adopts the \{Title\} style. In the second, \{font: VAGRounded-Light, size: 12\} is replaced by \{Standard\} style.
Fig. 4. Associating contents to styles

Using extraction tools this text is converted in an XML document using Docbook format. Docbook [11] is an XML-based standard format, usually adopted by publishing companies to describe publications like: books, manuals and texts in general. An important aspect of the Docbook format is that it does not represents any presentation format information, fostering single-sourcing policies. Instead of format, Docbook associates to any part of content structure a style information. For this reason, using the in loco semantics approach will convert text-processing style data into Docbook style-data.

Docbook is the starter point to convert the content to any desired presentation multimedia format. Conversions are usually based on transformations using the standard XSLT. They can take one or two steps, depending on the compatibility of the output format with web standards. For instance, Docbook content can be automatically converted in web-based content in one step, since the main languages used in this context are based on HTML or XML.

4. Large Scale “on-the-fly” Multimedia Production and Results

A significant and challenging problem found by Universities and content providers in distance learning context is how to produce effectively multimedia contents and, eventually, how to distribute multimedia contents in parallel and synchronously with courses execution. In effect, when considering the second point, two basic approaches might be considered:

- To develop and produce the course contents (all learning units) and distribute them upon completion of the production cycle; or
- To develop and produce course contents “on-the-fly”.

The first approach is more obvious but has the serious drawback of requiring a huge investment in order to be realizable especially in the case of long duration distance learning courses (2 to 4 years). The second approach is more realizable and “comfortable” in terms of the investment involved for most institutions, but do require a large scale trustable “on-the-fly” multimedia production process.
We have proposed and implemented a “knowledge to content to multimedia” decomposition and modeling process in which two basic problems found in multimedia creation and production are addressed: the conformance assurance against institutional pedagogical premises and the quasi-automation of the multimedia creation production line.

The main goals achieved with the described approach for a set of 11 long duration courses which are being “produced” in parallel and synchronously with course execution are as follows:

- A production line implementation using a set of general rules which are applicable to “content producers and actors”;
- A managerial control of the production process, for instance, with authors and supervisors being capable of producing support material which are lately formatted on different multimedia formats according with pedagogical needs;
- A truly scalable approach in which more than 40 people producing contents on various multimedia formats may interact and collaborate for producing effective collaborative support course materials;
- Finally, it has been also verified that the workflow process implemented leads to staff optimization in terms of specialized technicians and web designers involved.

6. References


