eduWEAVER: Integrated Design, Development and Deployment of eLearning Scenarios

F. Waldner, M. Nemetz, C. Steinberger

***Abstract*— The trend towards more didactics in eLearning and the increased usage of new media makes the design and development of courses increasingly complex. Only parts of the eLearning development process are supported by IT. As an effect, this may lead to a lower quality in eLearning material and courses, which in turn makes the possibility of participating in eLearning courses a rather unattractive option. In aiming to achieve a higher quality for eLearning-based courses, we introduce a conceptual model – the Course Creation Model – that serves as a guideline for designing, realizing, and evaluating eLearning processes. This model is applied with eduWEAVER, a web application that integrates design, development, and deployment of eLearning scenarios.**

***Index Terms*—eLearning, reference process, learning management systems, web application.**

I. Introduction

The content-centric view on e-learning from previous years is currently extended by didactical and pedagogical aspects [1] [2]. The aim is to combine the advantages of re-usability and interoperability of modular learning objects with a profound pedagogical basis, which is reflected in the release of the IMS Learning Design (IMS LD) Specification. This trend and the increasing usage of new media makes the design and development of courses increasingly complex.

Moreover only some of the eLearning development process phases are computer aided. Realization, rollout and deployment of eLearning products are comparatively well supported in form of author tools, learning management systems, audio and video tools and similar software. On the other hand there is still a lack on software supporting analysis and design issues of eLearning.

This leads to difficulties, such as for instance:

- an overall bad quality of eLearning
- low reusability of learning materials
- low reusability of best practice learning patterns
- high degree of dependence on specific available learning management systems (LMS)
- bad documentation of eLearning

We propose the use of a graphical modeling language in conjunction with a reference process for the course design and deployment foring these problems. With graphical modelling languages we are able to facilitate the design of courses in many ways. Advantages of graphical modeling languages in instruction are among others the more intuitive understanding, the better communication between experts, and the sharing of expertise and best practices [3].

This paper is structured as follows: In Chapter II we introduce the afore-mentioned conceptual model - the Course Creation Model (CCM) – that serves as a reference process model for the design, realization, and evaluation of learning processes. In this paper we focus on the roles of auditors and instructors to point out their responsibilities within CCM. Auditors, how they are understood in this paper, define courseware objectives and rough specifications, whereas instructors design courseware according to the auditor's specifications and eventually also perform the respective courses [4]. There already exist other development reference process models for the design, development, realization, and evaluation of processes in eLearning. For instance, the PAS 1032 specifications [5], [6] are a reference for the modeling of eLearning processes as well as for certain quality criteria for eLearning products. In Chapter III the CCM will be applied for describing the mode of operation of and with eduWEAVER, a web application that offers a graphical modelling language for instruction and integrates design and development into a single application that allows eventually an independent usage of course materials and structures by certain export functionality for and to LMS, HTML, and others [7][8]. Finally, the technical realization of eduWEAVER is presented in chapter IV. Chapter VI concludes the paper and motivates planned future work.

II. The Course Creation Model (CCM)

The CCM is made up of five subsequent phases, starting from the auditor's depiction of curricula in models, via the creation of an open reference process, the enrichment of the learning

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processes, the actual performance of the course and finally the quality checks and evaluation (Fig. 1). Relating to this development process of courseware we distinguish several roles to play their part during the development process respectively [4]. These are:

- Auditors, defining courseware objectives and rough specifications
- Instructors, designing the courseware according to the auditors demands
- Authors, developing learning materials
- Teachers, deploying the courseware and
- Students (often also referred to as learners)

In this paper we are focusing on the first two groups of involved people and point out their responsibilities within CCM.

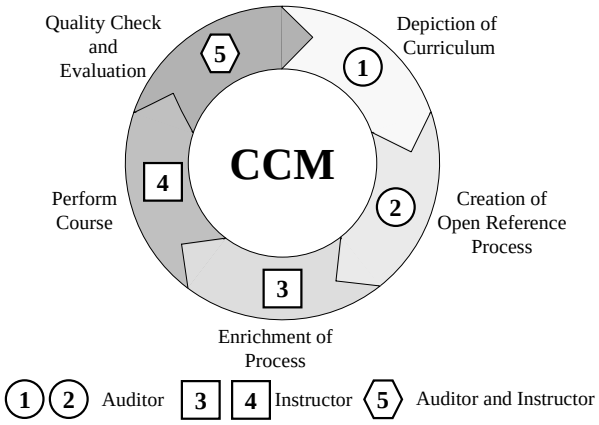

Fig. 1: The Course Creation Model (CCM)

A. Auditor

Auditors as how they are understood in this paper, are responsible for three areas of tasks:

1. Depiction of curricula from governmental or other authorities' guidelines: In many countries federal ministries or supervisory school authorities provide learning institutions with curricula on a variety of subjects. For example in Austria the Federal Ministry for Education, the Arts and Culture offers curricula for all classes of compulsory schooling in textual form which provide general information on the topics addressed within a course [9]. Similar to compliance initiatives in business process management (see e.g. [10] and [11]), learning institutions are interested in the standardization and alignment of curricula and lesson plans to guarantee high quality levels. These curricula could and should be depicted by the auditor in a format that allows the adding of didactical information as well as machine-based further elaborations of course structure, setting, and materials for being able exporting to and using diverse learning management systems.
2. Creation of open reference processes: Based on the above-described depiction of courses based on provided curricula, the auditor should create an open reference process model that allows further elaborations and adding by instructors ([12] and [13] propose modeling structures for courses and course materials). In this article we use the term reference model as a general description of a learning process that is valid for a number of more specific learning processes. The main advantage of this procedure refers to an initial situation of quality management as a quality-proofed course process is seen as the basis for any further course elaborations. Such mechanisms are nowadays widely used in other areas of modeling and business, respectively, such as for instance in business process modeling, where reference processes are applied in a variety of domains (e.g. [14]).
3. Quality check and evaluation: Based on the open reference model provided by the auditor by depicting governmental or other authorities' guidelines quality checks and evaluations could and should be performed within certain time intervals for guaranteeing a high level of quality. Such quality mechanisms could serve as profound argumentation for the certification of courses.

B. Instructor

The instructor in her role as a knowledge provider has got several possibilities for reaching students: (a) on-site training, (b) blended learning, and (c) online training. Depending on the diverse conceptions of training and learning, respectively, she may have to apply different structures and theories of knowledge transfer. Hence, as a result diverse technical means for supporting the instructor in her way of teaching should and could be applied. However, the restriction onto one (maybe even proprietary) system, such as a certain LMS does not represent an advantage. This counts even more if the instructor is giving courses in different schools or at diverse universities for different learner groups. Thus, an exchange of learning materials coupled with course structures, course routines, and course settings has to be foreseen. This aspect has to be also looked at, if blended learning, or online training come into play, as then also didactical principles have to be regarded in a per se purely technical realization method of course provision. And it is exactly the didactics that has not received enough attention in both research and practical realization of courses that refer to either blended learning or online training. In this paper, didactical restrictions could be understood as the option of applying diverse learning theories (such as material provision without much interaction, up to constructivist approaches, where students may have to find certain results simply by interacting and combining). However, in any case the course structure has to be adaptive. This aspect gains even more importance, when looking on the European Union's goal of life-long learning, where third age people shall be motivated to interact with learning technologies for enabling them to learn even after their professional lives [15]. However, although the contents may be the same, it is certain that other didactical standards are

required for a 65-year-old engineer than for a 20-year-old student of economics. However, it is not unlikely that one instructor is providing the required knowledge for both kinds of learners – third age as well as young people. To put it more simply: The didactics has to be flexible, whereas the contents shall possess a certain level of quality that must not be changed every time a different learner group is envisaged. And this is exactly the stage where auditor's are involved.
Based on the brief description of the two user groups – instructors and auditors – the afore-mentioned course creation model (CCM) for describing an ideal way of how to design course structures, settings, and materials shall be depicted, whereas starting from the auditor's depiction of curricula in models, via quality mechanisms, the instructors further specifications and designs of courses including didactical aspects shall be covered (Fig. 1). Responsibilities are indicated by the shape of the phase number. Auditors are in charge of phases with a circle (1,2), instructors of all phases with a square (3,4), and the hexagon shall illustrate that both auditors and instructors are responsible for quality check and evaluation (5).

III. EDUWEAVER

The tool eduWEAVER disposes several interfaces (see Fig. 2). They were developed in order to assemble several conjunctions between eduWEAVER, LMS, instructors, as well as between the pools of course sequences and learning material, respectively.

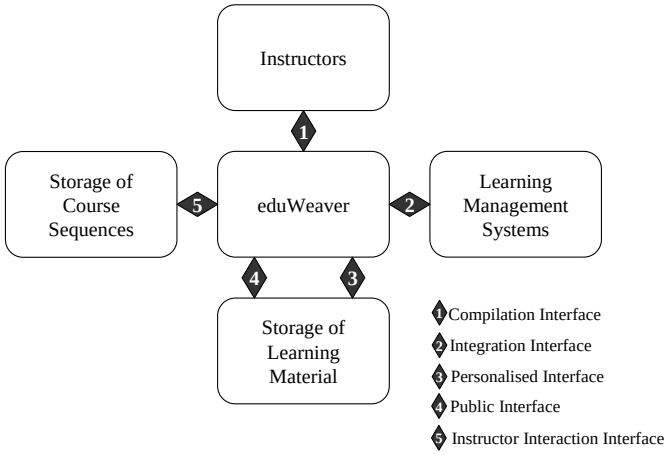

Fig. 2: Interfaces of eduWEAVER with its Environment [16]

Instructors feed eduWEAVER with course structures and learning materials via the Compilation Interface, where they commit the quantity and sort of learning materials and/or course structures that could be used in eduWEAVER.
Learning Management Systems (e.g. Blackboard, Moodle etc.) are platforms where edited course structures and learning materials can be imported from eduWEAVER through the Integration Interface. The Personalised Interface permits the storage of own learning materials within a personal pool of Learning Objects, though the materials are published through the Public Interface in eduWEAVER. The application of learning materials is possible only in accordance with the respective author. The storage of courses contains their sequences and structures and is directly connected with eduWEAVER via the Instructor Interaction Interface. Through the Storage of learning materials instructors may use the same materials in a variety of their offered courses, as it is depicted in Fig. 3.
In the following the Course Creation Model (CCM) will be applied for describing the mode of operation of and with eduWEAVER, as this web-based courseware modeling tool aims at supporting users over the entire CCM lifecycle. Thus, the following sections demonstrate how the sequential steps in the Course Creation Model (CCM) are carried out in eduWEAVER before eventually discussing the technical realization of eduWEAVER.

A. Course Creation Model

1) Depiction of Curriculum

The representation of learning and teaching activities in graphical process models is getting more and more attention [17, 18]. Learning is not just consuming content in a sequenced way [19]. It is a far more complex process that usually contains multiple interacting roles. A graphical modeling tool capable of depicting these processes can help to overcome the shortcomings of existing eLearning approaches that heavily focus on content. The goal is to provide user-friendly tools to instructors and auditors to produce high quality learning scenarios.

The eduWEAVER modeling method consists of four modeling levels: Course Map, Course, Module, and Lesson. These model types are hierarchically linked to each other by internal references. Within each level instruction processes are graphically modeled by using the according objects and relations on the selected granularity level [20] [21]. This representation allows the incorporation of the IMS Learning Design (IMS LD) Specification in the export functionality of eduWEAVER. Currently we are working on the details of how to match the IMS LD concept of Method, Act, Play, and Role-Part with the above mentioned structure in eduWEAVER.

The Course model in Fig. 3 represents a prototypical curriculum as it could be provided by governmental or other authorities. The curriculum is divided into four Modules, which gives only a brief overview of the contents addressed and contains no didactical considerations.

Fig. 3 covers the Integration Interface (2) and Instructor Interaction Interface (5) depicted in Fig. 2. Where the Integration Interface deals with phases 1 to 3 in the CCM, the Instructor Integration Interface is used when evolving from phase 3 to step 4.

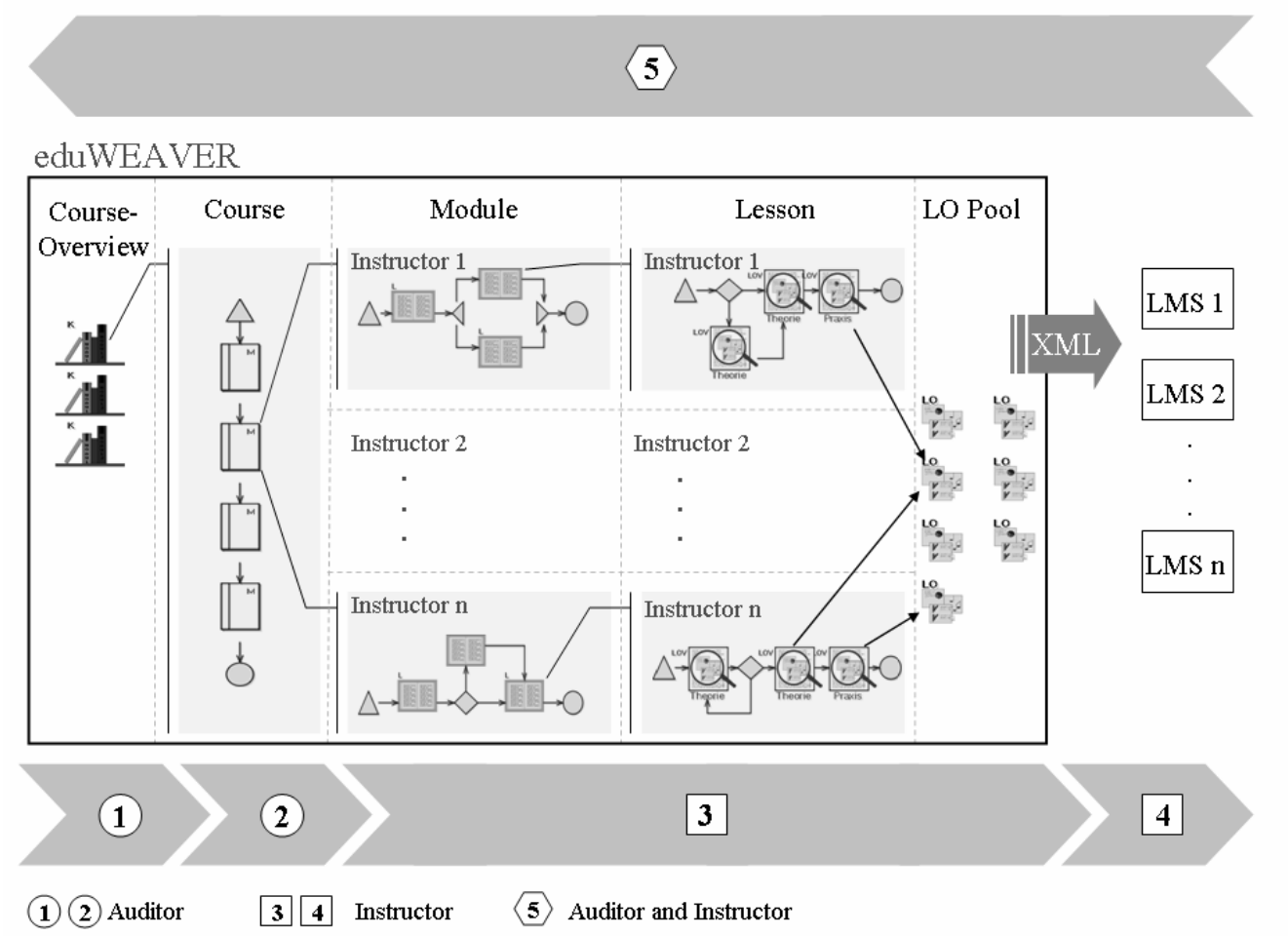

Fig. 3: The CCM applied on eduWEAVER

2) Creation of Open Reference Process

The hierarchical structure in the eduWEAVER modeling method gives auditors the freedom to create reference processes on different levels of granularity. While Courses give only a brief glance of the topic, Modules list the single lessons that are hold within the course. We propose that auditors provide instructors with a reference model on the Course level. Instructors are then in the position to design their lesson plans according to the given reference courses and their own didactical preferences (Fig 3). Given that case instructors determine the particular contents and materials used.

3) Enrichment of Process

The reference process provided by the auditor needs more detailing on the Module and Lesson level. Instructors have to enrich the reference models with didactical considerations. Possible considerations are to repeat or skip certain topics due to learner's level of expertise at a certain point in the course, or to add different types of learning activities. The modeling language in eduWEAVER offers parallel paths, decisions, and learning activities to depict such considerations (Fig.3).

4) Perform Course

The actual performance of a Course can happen in various ways. Instructors can use the materials in class, in blended-learning approaches, or in strict online-courses. Through an XML interface eduWEAVER is capable of exporting course models in SCORM, HTML, XML and ADL (Adonis Definition Language). Therefore instruction patterns modeled in eduWEAVER are usable in all major LMS (e.g. Moodle, Blackboard, Ilias).

All learning materials in eduWEAVER are stored in a central repository called Learning Object Pool. Course structures reference to the materials in the pool. Instructors can (re-)use each others learning materials by simply referencing to learning objects [19].

5) Quality Check and Evaluation

Auditors along with instructors should perform the quality check and evaluation. Results may lead to an adaptation of the reference processes and best practices may evolve.

IV. EDUWEAVER - TECHNICAL REALIZATION

eduWEAVER is realized with ADOweb®, which is a Java-based Web Services interface that supports browser-based online modeling with ADONIS®, a meta-modeling platform developed by the BOC Information Technologies Consulting AG [22].

Fig. 4 depicts the architecture of eduWEAVER. A Java Applet is used on the client side (Web Modeller). This applet communicates via middleware (Web Modeller Middleware) with the ADONIS web services. Learning materials within the Learning Object Pool (PowerPoint, PDF, etc.) and structure (learning patterns) are separated and stored in different databases.

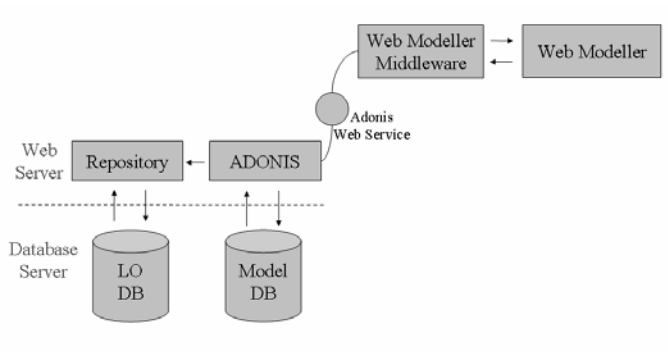

Fig. 4: The eduWEAVER Architecture

Additional export capabilities of eduWEAVER are provided by a XML interface and currently include generic XML, HTML, ADL (Adonis Definition Language), SCORM 1.2, and SCORM 2004. The SCORM 2004 export is in an early version and insofar it does not yet include the IMS Simple Sequencing Specification (IMS SS) [23].

The XML interface transfers modeled objects (Courses, Modules, Lessons, or Learning Objects) into XML-elements conforming to the chosen standard. JDOM is used to generate the XML manifest files for the different standards. JDOM is open source and provides an efficient way of reading, manipulating, and writing XML documents in Java [24].

Class	Attribute (in eduWeaver)	LOM (SCORM 2004)
Course Map	Name	General/Title
	Description	General/Description
	Keywords	General/Keyword
	Version	LifeCycle/Version
⋮	⋮	⋮
LO	Name	General/Title
	Description	General/Description
	Keywords	General/Keyword
	Language	General/Language

Table 1: Matching of XML Elements and Attributes

Table 1 shows a small excerpt of how attributes of modeling objects, such as Course Map or Learning Objects that are eventually assigned to XML elements in the SCORM 2004 export (in particular the metadata of different modeling classes).

The following code illustrates how the mappings shown in Table 1 for the model type Course Map are implemented in Java using JDOM. In the first line a new element <*general*> is created. This element contains the element <*title*> to which the name of the course map is added by using the function *getName()*. As indicated in Fig. 3 (XML), below a small excerpt of the code structure for the serialization of the graphical models.

```
Element general = new Element("general");
Element title = new Element("title");
title.addContent(model.getName());
general.addContent(title);

Element description = new Element("description");
description.addContent
        (model.getAsString(attr_description));
general.addContent(description);

Element keyword = new Element ("keyword");
keyword.addContent(model.getAsString(attr_keyword1));
keyword.addContent(model.getAsString(attr_keyword2));
keyword.addContent(model.getAsString(attr_keyword3));
keyword.addContent(model.getAsString(attr_keyword4));
general.addContent(keyword);

lom.addContent(general);

Element lifecycle = new Element ("lifecycle");
Element version = new Element ("version");
version.addContent(model.getAsString(attr_version));
lifecycle.addContent(version);
```

This code generates the XML tree below, where in this example *BPM* is the title of the Course Map, *descr*. is the textual description of the course, and *key1* to *key4* are the keywords for this Course Map:

```
<lom xmlns="http://ltsc.ieee.org/xsd/LOMv1p0">
  <general >
    <title>BPM</title>
    <description>
      <string>descr.</string>
    </description>
    <keyword>
      <string>key1</string>
      <string>key2</string>
      <string>key3</string>
      <string>key4</string>
    </keyword>
  </general>
  <lifecycle >
    <version>
      <string>1.0</string>
    </version>
  </lifecycle>
</lom>
```

The tool eduWEAVER is available with free access for schools, universities and polytechnics via the internet page http://www.eduweaver.net.

V. Summary and Future work

The herein presented tool eduWEAVER may overcome the deficiencies and difficulties mentioned in the introduction by:

1. improving the quality of eLearning contents by distinguishing two roles: auditor and instructor
2. reaching a high rate of reusability by applying a four level structure of courses
3. realising high quality best-practice "learning flows" by applying the modeling approach in eduWEAVER
4. being independent from learning management systems due to offered export functionality in eduWEAVER
5. achieving good documentation by using the HTML or XML export functionality in eduWEAVER

For achieving these advantages in eduWEAVER, a conceptual model – the Course Creation Model (CCM) that is depicted in Fig. 2 was presented in the course of this paper. It illustrates the interdependencies between the two roles of auditors and instructors.

Currently we are implementing IMS LD export functionality. The challenge there lies in the matching of the eduWEAVER modelling method with the conceptual model of IMS LD. The next task planned is to implement detailed rights management for the learning objects stored in the central repository. Up to now it is only possible to graphically indicate property rights on learning objects, but not to exclude others from using them. The authors of learning objects shall be empowered to denote upon what degree they are willing to share their work.

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