

Interoperability between MOT and Learning Management Systems: Converting CAF to IMS QTI and IMS CP

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Abstract. The chain of applying adaptivity to Learning Management Systems (LMS) is still deficient; there is a gap between authoring adaptive materials and delivering them in LMS. In this paper, we extend My Online Teacher (MOT), an adaptive authoring system, by adding compatibility with IMS Question & Test Interoperability (QTI) and IMS Content Packaging (CP). Thus, the authors can *utilize the authored materials for learning process adaptation on any standards-compatible LMS*. From a technical perspective, we initialize the creation of adaptive LMS by converting Common Adaptation Format (CAF), XML representation of MOT database, into IMS QTI and IMS CP, to ensure a wider uptake and use of adaptive learning systems. Finally, this work represents a significant step towards the little explored avenue of *adaptive collaborative systems* based on extant learning standards and popular LMS.

Keywords: Adaptive authoring, MOT, LMS, IMS QTI, IMS CP.

1 Introduction

Authoring of adaptive material is, generally speaking, a challenging arena. A clear weakness appears specifically when it comes to delivering these materials to students using regular Learning Management Systems (LMS). While [4] considers adaptive authoring a “*serious problem*”, it also provides two applicable approaches to solve it: 1) a *common language*, a lingua franca, used by all authors of Adaptive Educational Hypermedia (AEH); and 2) usage of *converters* between AEH systems. Thus, in our work, we follow a combined approach, by developing promising *converters*, which use adaptation materials as input and produce *standardized* material (the most widely accepted lingua franca) as output. Thus, we move one step forward from previous research, by limiting the lingua franca, to the degree it is possible, to existing standards. A large body of research states that standards cannot incorporate all requirements of an adaptive hypermedia [6]. However, as standards progress, it is unwise to ignore them. LMS rely heavily on standards, and are very popular. Therefore, if adaptive hypermedia is to move into the large-scale use and commercial market, it has to be able to interface with – or extend – existing LMS.

1.1 MOT and CAF

MOT is an adaptation authoring system based on the LAOS (*L*ayered *W*WW *A*uthoring *M*odel and their corresponding *A*lgebraic *O*perators) framework [3]. The Common Adaptation Format (CAF) reflects the content-related data structure of the MOT database; however, it uses XML representation, which is more suitable for web conversions. Thus, a CAF XML file has: 1) *Domain model*: containing a hierarchy of concept(s); as well as a collection of attribute(s) that describe related concept data. A concept may have sub-concept(s) that represent associations to other concepts. An attribute has a name and contents. 2) *Goal model*: The goal model represents the actual lesson, which may have a set of sub-lesson(s). Each lesson is composed of a set of link(s) where each link points to an attribute in the domain model. The link has two attributes: weight and label, which are used to determine the adaptive requirements via adaptation strategies (not detailed here due to lack of space).

2 Converting CAF to IMS QTI and IMS CP

We present a unique and novel initial step towards applying adaptation in LMS. This is a two step process: firstly, we convert CAF to IMS QTI and IMS CP; secondly, we import the converted results into a popular LMS, e.g., Sakai. To tackle the difficulties and challenges found in our work we use the Java Architecture for XML Binding (JAXB), as CAF, IMS QTI and IMS CP are based on XML and can be thus processed (see URL at: <http://als.dcs.warwick.ac.uk/mot/>).

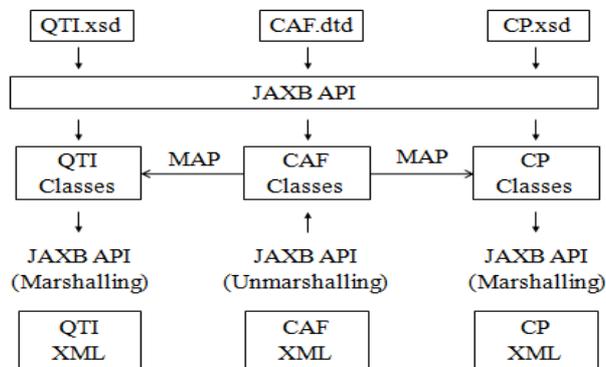


Fig. 1. JAXB facilitate converting CAF to IMS QTI and IMS CP.

2.1 The Utilization of JAXB

As is illustrated in Figure 1: firstly, we generate Java classes for CAF.dtd, QTI.xsd and CP.xsd; secondly we parse (i.e., *unmarshalling*) the CAF XML file and generate

Java objects; thirdly we map the results onto IMS QTI and IMS CP classes accordingly; finally we generate (i.e., *marshalling*) IMS QTI and IMS CP.

2.2 Converting CAF to IMS QTI

The IMS Question & Test Interoperability (QTI) is a data model and *de facto* standard for the representation of questionnaires and quizzes. Compared to the structure of CAF, we map the main lesson of the goal model into one ‘assessment’; and the domain model into one ‘section’. Each attribute in CAF is mapped to one item in IMS QTI. CAF has a hierarchical structure; however, IMS QTI has a flat one. Therefore, the hierarchical structure is flattened. As JAXB facilitates the mapping process, our algorithm *unmarshalls* the CAF file, and finds the concepts which contain “question” and “answer” as attributes, then it *marshals* the generated IMS QTI file with the “question” and the “answer”. The question-answer pairs in the concept are retrieved from the goal model rather than from the domain model, which reflects the effective use of the authoring in MOT.

2.3 Converting CAF to IMS CP

The IMS Content Packaging (CP) is a *de facto* standard, which describes data structures that are used to provide interoperability for the contents of Learning Management Systems (LMS). Therefore, IMS CP provides standardized data structures that can be used to exchange content. The structure of IMS CP consists mainly of: 1) *Manifest XML file*: describing the contents’ hierarchy, and pointers to the actual contents (physical files), and 2) the actual *physical files* (resources). IMS CP has more flexibility than IMS QTI, amongst which, the fact that it also supports hierarchical structures (same as CAF). Therefore, each attribute of each concept in CAF is mapped to one item in IMS CP with the preservation of the hierarchy. The attribute’s *name* is converted to *title* of item and the attribute’s *content* is mapped to the actual resource that matches the item.

4 Discussion

The CAF to IMS QTI converter manipulates adaptation content in CAF format and generates the matched assessment in IMS QTI; here we have two benefits from an adaptation point of view: 1) utilizing the adaptive parameters in CAF, and 2) enrich the generated assessment with new adaptive concepts using LOM in IMS QTI. Using assessments together with personalized learning access has a positive impact on the learning process, because it helps in: 1) checking if the learners have understood the materials correctly or not, and 2) providing feedback for both learners and teachers. Therefore, adding assessment potentials to AHES will enhance the learning process and give the students the chance of tracing their learning progress [1].

On the other hand, creating adaptive content is considered costly and time-consuming [2]. Therefore, reusing already created content is valuable, and this can be

done by providing facilities to export the adaptive content into standardised format, such as IMS CP. The CAF to IMS CP converter performs this by partitioning the adaptive content into unique granularly items that can be reused for different learners. Moreover, those items can be enriched with metadata that follow the LOM standard to give a new dimension to applying adaptivity in LMS that support IMS CP.

5 Conclusion and Future Work

The majority of adaptive learning systems focus on personalizing the delivery of course materials to individual learners. However, little work has been done on applying adaptivity on collaborative learning systems. Converting adaptive content into learning standards can supply a dynamic learning process which is compatible with all systems that support these standards. In this paper we present the interoperability between adaptive authoring and Learning Management Systems by converting CAF into IMS QTI and IMS CP. Thus, the authored adaptive materials in MOT can be imported to well-known LMS such as Sakai. This is a first step towards the novel endeavour of bringing adaptation into collaborative LMS. For future work, we intend to apply adaptation on IMS QTI and IMS CP by using LOM (Learning Object Metadata) [5] – which is supported by IMS QTI and IMS CP - by enriching materials with further adaptation metadata.

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