

# **DEFINING ADAPTIVE ASSESSMENTS**

## ***Construction of Adaptive Assessments Based in the Learning Style of the Students***

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**Abstract:** This article presents a proposal to define learning objects for adaptive assessments. Two adaptation processes are described here, the first one is the adaptation in the level of complexity of the questions, and the second one is our proposal to adapt the final presentation according to the user's learning style. To define the items and exams, a model to construct adaptive assessment and a proposal of three levels of integration is detailed.

## **1 INTRODUCTION**

The educative content is evolving from a static view to an adaptive one in which the content is adapted to the needs and/or preferences of the users. This content, developed in form of units of learning look to cover a specific learning objective including one or several learning objects and their related material.

Inside those objects we can find objects describing assessment activities to evaluate the knowledge of the students. The assessment activity inside a unit of learning could be seen as an element that closes and complete a circular activity, being an integral part of the learning process (Barbosa & García, 2005).

Nowadays, it is necessary to produce educative Internet-based systems that permit the dissemination of the education, covering the needs of diverse learning group profiles. To obtain this, it is desirable that such systems perform automatic task to adapt itself to each user, disconnecting the content from its presentation by using a semantic approach rather than a syntactical one, defining a meaningful web. In consequence, learning systems must be flexible and efficient, and one way to accomplish that is to be an open and standardized system (Barbosa & García, 2006).

In addition, the assessment activity inside the e-learning process could be used to adapt the system

by setting a new user knowledge level, evaluate, and setting new learning profiles, assign user grades and, in consequence, performing user content re-adaptation (Barbosa & García, 2005b). According to the Australian Flexible Learning Framework (Backroad Connections, 2003), assessment, especially when is included within a real learning task or exercises, could be an essential part of the learning experience, giving to the entire Web site the characteristic to adapt itself to the needs and the acquired knowledge of the users.

The rest of the paper is structured as follow: In section two, we present the model overview, organized in levels of abstractions and sections for each stage of activity. In the section three we briefly describe the construction of simple items using open standards and the definition of complete exams containing groups of simple items. In the fourth section we present the integration levels going from simple items (first level) to complete exams with adaptation rules. In the fifth section we describe the adaptation processes in the final presentation (adapted to the learning style) and the adaptation in the complexity level. Finally we give our conclusions and future work.

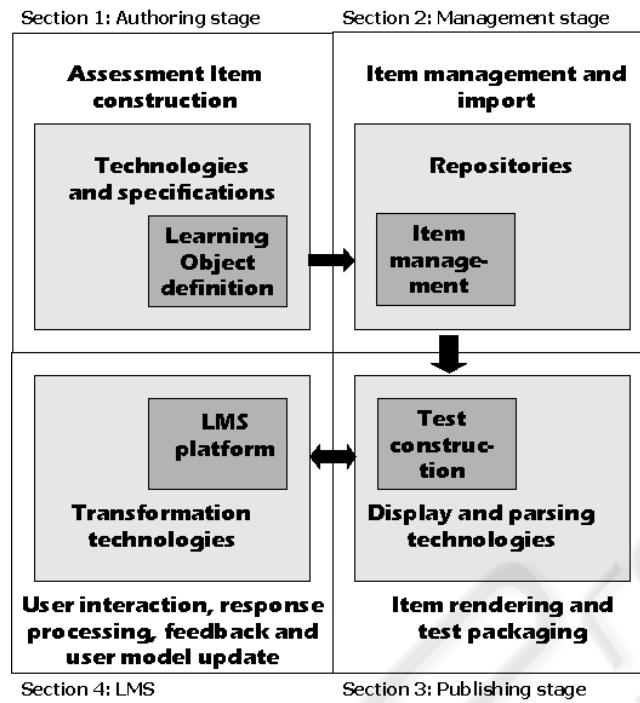


Figure 1: Model to construct adaptive assessment items.

## 2 MODEL OVERVIEW

We propose a model to construct assessment items with characteristics of adaptability. This model have four main sections (figure 1), some of them have three levels of conceptualizations with activity definitions form the abstract level (lower layers) to a more concrete level (upper layers) to a more concrete level (upper layers).

We structured the model starting with the definition of the basic core elements so we can evolve them to a more concrete definition, identifying their requirements and interactions between them at the same time (Barbosa & García, 2006b).

### 2.1 Levels: From an Abstract to a Concrete View

In the first level (dark colour), we identify the core elements (learning objects, management, test construction, and LMS (Learning Management System) interaction). In the second level (grey color), we describe the main sections, identifying four phases: authoring, repository management, visualization, and interaction with LMS. In the third level (white colour), we categorize each activity into

a subsystem (authoring, item management, publishing, and interaction with LMS).

### 2.2 Sections: From the Creation to the Interaction With the LMS

**Section one:** Learning Objects Definition (ASI: Assessment, Section, and Items). We focused our research in technologies and specifications in the definition of this section; we use the authoring use-cases of the IMS QTI specification (IMS QTI, 2006). In addition, we want to use the IMS Learning Design specification (IMS LD, 2006) to define a resource-learning object in three different levels of integration.

**Section two:** Item Management. We define this section with the aim to give to the developer a tool to organize, manage, and import ASI from other authoring tools. We propose a native XML (Extensible Mark-up Language) (XML, 2006) database management system to manage the items.

**Section three:** Test Construction: We consider in this section the activities made by the assessor to view the items by rendering them in a visualization system. We suggest using accepted software plugins to show a final rendering to the user. In this section, the assessor selects the ASI to construct the test that will be delivered into LMS in a XML format. In addition, we want to integrate data fields

so the assessor could construct adaptability test by defining trees of related questions depending of the responses and the feedback presented to the user. We propose the development of a user interface for the students or candidate so they can access and respond to the exam, sending the results to the LMS to make an assessment record.

**Section four:** Test Delivery: In this phase, the candidate or student activates the test by accessing to it through an LMS, from which we get the learning style definition to make the adaptation.

### 3 DEFINING ASSESSMENT ITEMS AND EXAMS USING IMS SPECIFICATIONS

#### 3.1 Defining Items Using IMS QTI and IMS CP Specifications

The IMS CP specification is used when is necessary to transfer learning objects (lessons, exams or other material) between several Learning Management Systems. In this case we can use this specification to package and transfer assessment items between LMS. In the case of a simple element, the package will contain (a) the manifest (XML file called imsmanifest.xml), (b) the item (QTI XML format file) and, (c) any auxiliary files required by the item (ref: ims qti integration guide).

#### 3.2 Defining Exams Items Using IMS QTI, IMS LD and IMS CP Specifications

The IMS QTI and IMS LD specifications allow their integration to define a learning object to evaluate the knowledge acquired by the students when interact with an unit of learning (UoL). The IMS LD includes activities of course instruction, modules, lessons and exams in a generic context (those considered as formative assessment) to support the recent knowledge or to give immediate feedback to the student.

But the IMS specifications could be used to define learning objects with extra characteristics like adaptation rules for the final presentation and sequence of the questions.

The main structure defined in a IMS LD object is the manifest, containing the organization and resources. Inside the organizations section some elements are described, like the roles, properties, activities, environments and methods. The

integration of the specifications could be done defining tags and instructions in the *imsld:properties* to control the visibility and order of the elements and the *imsld:conditions* to define decision structures.

The environments section is a container for the environment elements, each could be used to describe assessment items for a particular learning style. These structures (the environment ones) could be executed by the LMS in parallel, allowing multiple students of different learning styles to access their own adaptable elements (or an adaptable exam).

### 4 PACKAGE CONFIGURATION FOR ITEMS AND EXAMS

#### 4.1 First Level of Integration: Simple Items

This is a package (figure 2) that contains a simple item or question and the multimedia files or references to them. The purpose is that this package could be exported to third-party authoring tools or to be referenced by learning objects like those constructed using the IMS LD specification in formative exams. This object is supposed to include the question description in IMS QTI and the reference to the multimedia file that will be used for the LMS when the item is displayed to the student.

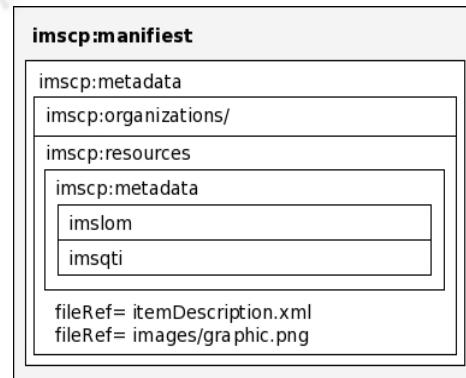


Figure 2: First level of integration for items.

#### 4.2 Second Level: Many Items, One Learning Style

This package (figure 3) contain many question items and hence a complete exam for a single learning style. This package could be constructed by selecting a group of items with the same educational objective (to evaluate an unit of learning) and

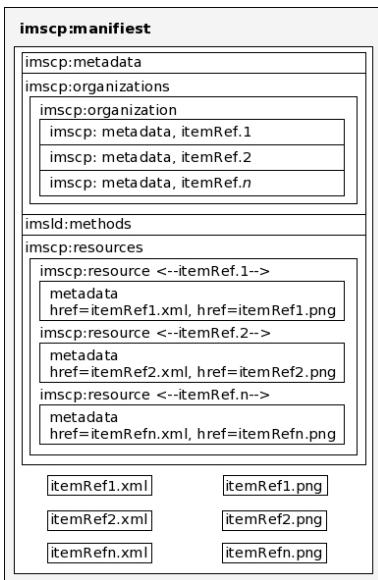


Figure 3: Second level of integration for exams.

categorized for the same learning style. In this level IMS LD metadata is defined and sequencing instructions for the final presentation are defined as well, using rules defined in the *imsld:methods* section.

### 4.3 Third Level: Many Items, Many Learning Styles

This package (figure 4) describe a complete exam, with several components: (a) an environment for each learning style, (b) a method section describing the adaptation rules for the sequencing, (c) the resource section, containing the description of the resources for each learning style and the files (or the reference to them) to support the adaptation to the final presentation to the student.

## 5 ADAPTATION PROCESSES

### 5.1 Adaptation in the Final Presentation to the User

The learning object could adapt their final presentation taking into account the needs or preferences of the users. For this, the learning object containing an adaptable exam includes content for each learning style through the use of a specific context or environment. The LMS access the appropriate environment that fit to the user learning style or preference, showing the multimedia

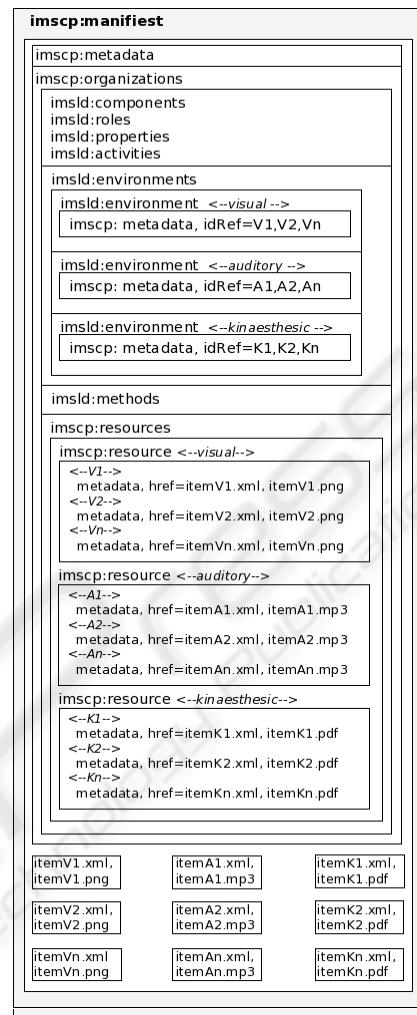


Figure 4: Third level of integration for adaptive exams.

material. For example, the next sentence (figure 5) consider the ability level and the learning style of the student to show the next question with the right multimedia material

### 5.2 Adaptation in the Complexity Level

Another process of adaptation is the level of complexity of the questions that are presented to the student (figure 5). The questions are selected by their level of complexity, taking into account the response of the student to the last question answered. If he/she answer correctly then the next question is of the same or higher complexity, if not, then the next question is of a lower complexity. This is the traditional adaptation process used by some developments in this area (Gouli *et. al.*, 2001), (Guzmán *et. al.*, 2005).

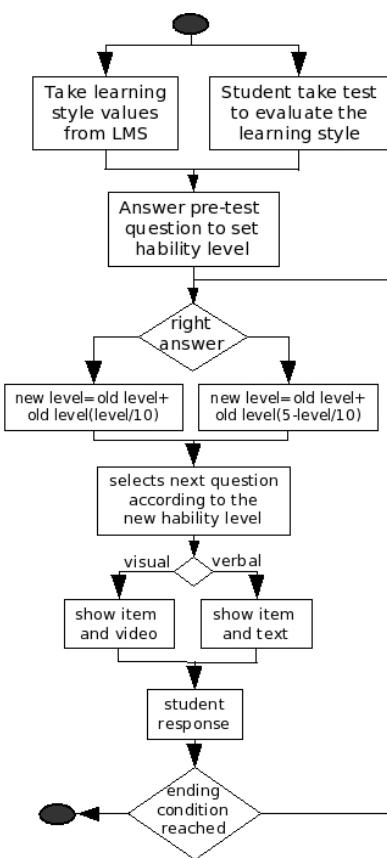


Figure 5: Adaptation processes.

### 5.3 Adaptation Rules

One of the main characteristics of the IMS LD specification is its potential to define adaptive characteristics covering the student preferences, prior knowledge and/or learning needs. To do this it is necessary to use this specification in the level B to define individual interactions because in this level we can use some elements like `<properties>` and `<conditions>`.

The learning style values could be set from values stored in the user model in the LMS and stored in property elements (`<locpers-property>`, `<globpers-property>`) to perform the adaptation. Finally, the `<on-completion>` element could be used to set the actions that will be done once certain action is performed. To perform adaptability to the learning style the LMS access the environment according to the need or selection of the user. From this, the questions set are presented to the student applying the adaptation algorithm proposed by (Stern & Woolf, 1994).

Adaptation rule RUL1 is to perform adaptability according to the ability level and RUL2 is to adapt the presentation to the user learning style.

```

RUL1= IF <student>::(response,true)
THEN
  newLevel = oldLevel+
  oldLevel(oldLevel/10)
ELSE
  newLevel = oldLevel+
  oldLevel(5-oldLevel/10).
  
```

```

RUL2= IF <student>::(LS_visual)
THEN
  show item (newLevel,visual)
ELSE
  show item (newLevel,verbal).
  
```

## 6 CONCLUSIONS

Online assessment is an important step inside the e-learning process because gives convenient feedback to all participants in the process, helping to improve the learning and teaching experience.

Given the fact that assessment is an important element of the e-learning process and that this process looks to be interoperable, then we can think that the assessment tool could be used with different educative content administrators with different conceptualizations and ways to design and apply a test for their students. To face this situation it is necessary to develop an assessment tool that give several ways to design an test with different types of resources, different kind of assessments, group of students, kind of questions, managing schedules, etc. Under this conceptualization, we propose to construct assessment items incorporating adaptive characteristics taking into account the learning style of the user, besides the adaptation process in the level of complexity of the questions, already in use by some assessment tools. We propose to incorporate adaptation rules using the IMS LD specification in an exam to construct a learning object that could be used by the LMS.

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