

Creating personalised quizzes both to the learner and to the access device characteristics: the Case of CosyQTI

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Abstract. In this paper, we present CosyQTI, a tool for authoring adaptive assessments, which gives the educator/ author significant flexibility in terms of the adaptation that s/he can incorporate in the assessments s/he builds. The assessments can be accessed via a variety of access devices including desktop and handheld ones. We illustrate the architecture of the CosyQTI tool and advocating that the tool fully conforms to the IMS_QTI and web standard, serving the goal of interoperability.

Keywords: Adaptive educational hypermedia systems, Adaptive assessment authoring systems, Standards.

1. Motivation

Computers are increasingly being used in the assessment process in many educational situations and several initiatives have been set up. For example, the e3an (Electronics and Electrical Engineering Assessment Network) project has developed tools for collecting, storing and disseminating questions [<http://www.e3an.ac.uk>]. Various vendors have proposed commercial self assessment tools, like QuestionMark [<http://www.questionmark.com>], Can Studios [<http://www.the-can.com>], etc.

Although these tools enable instructors the creation of various types of assessment exercises (e.g. multiple choice, fill-in the blanks, hot spots, and so on), they do not offer functionality for the adaptive presentation of exercises based on instructional rules. Adding the adaptation capability to the assessment process has been proven advantageous, primarily for the reason that learners are presented with personalized tests, tailored to their needs, preferences and current knowledge, but also because the number of assessment items required can be adjusted, most of the times resulting in fewer items, which implies a shorter, less tedious assessment [1,2]. Only few such adaptive tools can be found in the literature such as to SIETE [3], CATES [4], TANGOW [5]. Details about the hypermedia adaptive assessment tools can be found in [5].

The goal of this paper is to present an innovative tool, which is called CoSyQTI tool, that supports the authoring process and presentation of personalised and adaptive web-based assessment. Adaptation in our research means two things:

- i) the generation of a dynamic sequence of questions depending on learner's responses and estimation of his/her knowledge level, as defined by Pitkow and Recker in [6]. It has been showed that web-based adaptive questionnaires can reduce the number and complexity of questions posed to users.
- ii) The adaptation of the content of web-based tests to the learner's access device characteristics such as screen dimensions, storage capacity and processing power. In our user case, the tool can be accessed by a PC system, a personal hand-held device (PDA) in compliance with Wireless LAN technologies (802.11b-g) and a 3G cellular device or one compliant with WAP technologies.

Moreover, the CoSyQTI has another innovative feature. As learners answer the presented assessment items, the learner model is updated in order to reflect the current status of their knowledge level as well as to keep logs of the whole interaction. Although in most assessment systems the learner model is not usually accessible by the learners, CoSyQTI allows learners to access parts of their model. It has been argued that the act of viewing representations of their knowledge level can raise learners' awareness of their developing knowledge, and difficulties the learning process, thus leading to enhanced learning [7,8]. In CoSyQTI the learner can alter his/her knowledge level at will or negotiate the changes with the tool and come to an agreed representation. In the mobile learning arena, few systems such as C-POLMILE and MoReMaths (Mobile Revision for Maths) [9], offer open learner modelling.

In this paper, we illustrate the main features of the CoSyQTI tool. While section 1 gave an overview of the motivational aspects of our research providing a brief introduction to the notion of adaptation in the assessment systems, section 2 will present the adaptation mechanisms of the CosyQTI. We will analyse the adaptation mechanisms, the XML manifest of the subject domain, and the learner modelling techniques. Finally Section 3, will comment on evaluation results and give directions for further research.

2. Adaptation in the CoSyQTI tool

2.1 The adaptation philosophy

CoSyQTI's approach advocates that the author of an assessment, i.e. the educator, should be able to make decisions on matters such as:

- which questions should be considered easy or hard,
- how are grades to be interpreted in terms of the user's knowledge level,
- how many questions are necessary to estimate the learner's knowledge with confidence,
- how is the learner's performance going to affect the learner model and many more.

With CoSyQTI, authors are able to create the following type of questions:

- True/False
- Multiple choice – single, multiple or ordered response
- Image hot spot item

The assessments created fully conform to IMS QTI specification (Question and Test Interoperability) [10], so that they can easily be exported and used by other applications which are also IMS compliant. Furthermore, authors can later open and edit an existing assessment. The IMS QTI initiative proposes the representation of assessment tests in standard XML format, thus allowing interoperability between different assessment tools. QTI structures tests into assessments, sections, and items. An item is the formal name for a question within QTI,

and an assessment is the name used for a test within QTI. The terms "item" and "assessment" are considered more precise and useful for the formal specification, than the looser but more widely understandable "question" and "test" words used in the QTI title.

Nevertheless, CosyQTI innovates by introducing the use of XSL templates (XSLT transformations) designed to adapt the XML formatted questions to the learner's device's specific characteristics like screen dimensions, network availability, storage capacity and processing power.

2.2 Adaptation to access device characteristics

CosyQTI adapts the question items to the access devices' characteristics. The content tagging is a feature that is mainly exploited when adapting the assessment items to the devices characteristics. Predefined elements of the IMS QTI XML manifest are used in order to fragment the assessment content in order to fit into smaller displays like PDA's or WAP cellulars. For example, in Figure 1, the content of a Question is presented in smaller fonts and minimized dimensions when displayed in a PDA compared to a PC, with the use of XSL stylesheets. In an even smaller display, such as a Wap phone, the same content is divided into two element fragment; the Question and the given answers. It should be noted that the example below is indicative in order to illustrate the look-and-feel and is not part of e-learning activities.

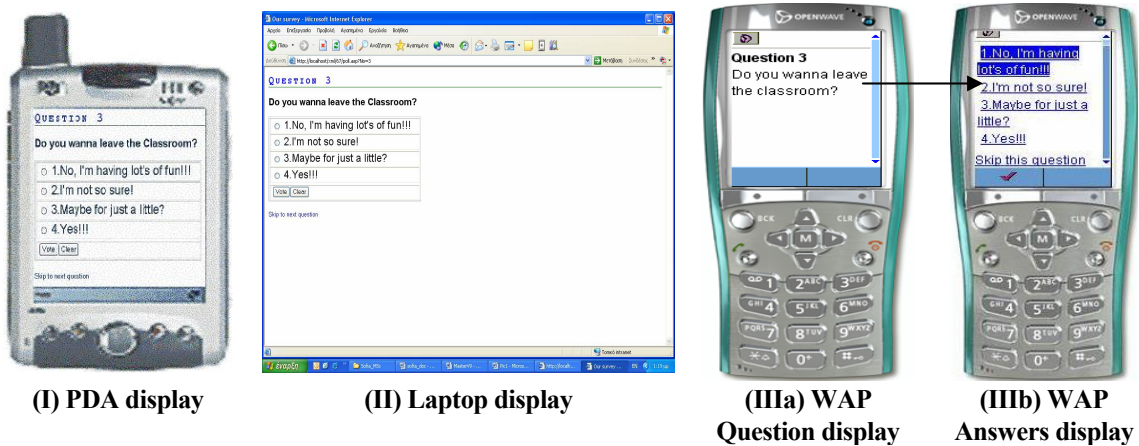


Figure 1. Displays of an assessment item in various access devices (PDA, Laptop and WAP cellular).

2.3 Authoring process of adaptive tests

The CoSyQTI tool allows the author to create both adaptive and non-adaptive assessments. The first thing that the author has to do is to create the assessment. As already written in section 2.2, the tool conforms to the IMS QTI specification. Of course, the author does not write any XML code for creating the assessment. In fact he fills in simple web-based forms like the one presented in Figure 2. The editing tool for the assessment supports only desktop and PDA displays and not WAP ones.

True/False Item

Items with an asterisk(*) are required

Write the title of the Item*

Write the T/F statement*

Enter a hint for the question

Select if answer is True or False True False

Number of attempts Penalty for using the hint

Maximum score of question Minimum score of question

Difficulty Level

Figure 2. Screen for creating a True/False Question

When the assessment is created, the author can manage the entire assessment from his screen, being able to edit the rules that will be applied to selected items/sections. These rules take the form of IF <condition> THEN <action> rules, where the <condition> refers to the learner's knowledge level on a particular topic, her/his score and/or the assessment's difficulty level, all checked at a given moment during the assessment. This moment is called the rule's trigger-point, it can be any point in the assessment and it is also defined by the author. The <action> refers to the resulting change in the assessment and currently includes a change in the user's knowledge level on the section's topic, a change in the assessment's difficulty level and/or moving the user to a different section. Figure 3 depicts the screen through which the author builds an activation rule and specifies the trigger point, the action that will happen when it will be applied.

Rules Description

Rule Name:

Conditions

- When student is at level..
- When student has score..
- When student has knowledge level.. at the topic..

Actions

- Set knowledge level for section's topic..
- Move to section..
- Move to level..

Description

then

Trigger Point

Figure 3. Screen shot of CoSyQTI authoring environment for building adaptive rules for an introductory course on computer science

The questions that will be presented to the learner are displayed on the fly, according to the set of rules that the author creates.

The algorithm used by the CoSyQTI tool to activate and deliver an adaptive assessment can be summarized in the following:

```
If (initialization rule applies) then
    update item selection criteria
Do
    Select appropriate item to present
    Receive Answer
    If ( rule applies) then
        If (rule is of LearnerModel_update type) then
            update LearnerModel accordingly
        Else if (rule is of item selection type)
            update item selection criteria
While (NOT end of assessment)
Update LearnerModel accordingly
```

2.4 Learner model description

A learner model in an AHES is essentially the information the system holds about the user and is mainly related to the learning process. This information has to be such that the system can better adapt to the user's individual needs. When observing the learner-computer interaction, several adaptations can take place, some of which do so explicitly and some implicitly, based on the interactive events, the path that the learner has taken, the performance concerning some learning tasks, etc [2]. An adaptive or adaptable educational hypermedia enriches the application functionality by maintaining a "representation of the user" (or "user model") and providing customization mechanisms to modify application features in response to learner model updates. For adaptive educational hypermedia, user model updates are automatically generated by the system (by monitoring and interpreting the user's interactions); for adaptable hypermedia, user model updates are under the user control. The adaptivity/adaptability feedback could be related to the organizational and presentational issues of the learning resources (permission to move forward, encouragement to read specific sections, undertake some tasks, etc.).

The user model used by the CoSyQTI has resulted from the selection and combination of elements from IMS LIP and IEEE PAPI [11] standards. Specifically, it consists of the following elements:

- Demographic data - data that remain unchanged, such as age, gender, etc.
- User goals, which are related to the long term and short term learning goals related to learning objectives of specific concepts to be learnt (e.g. "to complete course X").
- User preferences, with respect to the various dimensions of the learning opportunity (e.g. the mode of delivery, accessibility requirements, or assessment).
- User knowledge, which includes the knowledge level about concepts to be learnt and weaknesses and strengths on particular areas, sections or points of the concepts.
- Usage data – historical data which include information like which pages were viewed, in what order, for how long, etc.

The first three elements are considered to be changeable only by the user, whereas the last two are monitored and updated by the system. Goals and preferences are not being exploited in the present version of the system.

There is only one learner model that describes a user of our system, contrary to SIETTE that uses two: a temporary student model with performance information and a more permanent student model, which is also more complete. The learner accesses the hypermedia content of the assessment in the most appropriate user interface design and requests data according to

his/her preference. This request is passed to the server that will return the data matching the requested data to the user profile. The aforementioned approach is shown in figure 4.

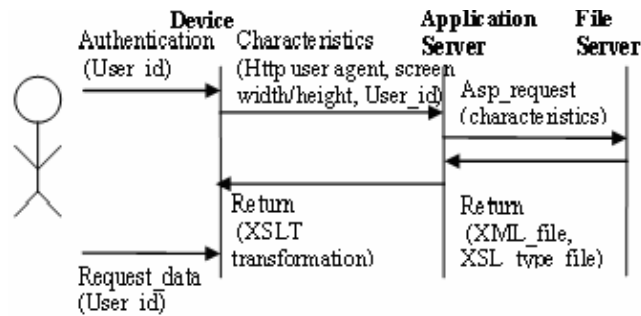


Figure 4. The sequence diagram of the adaptation mechanism in CoSyQTI

3. Evaluation

CoSyQTI is a web-based tool for creating adaptive assessments giving the author the opportunity to define his/her own adaptation rules. The tool can be accessed via various handheld devices. It conforms to the IMS_QTI specification, allowing interoperability. The learner model used has resulted from the combination of elements from IMS LIP specification and IEEE PAPI [11] standard. The CoSyQTI has not been tested in full within real classroom environments. Only small scale usability evaluation studies in a lab have been performed. More specifically, the tool's usability was tested by giving it to 3 users, who are teachers attending an MSc programme on Advanced Learning Technologies. We asked them to perform a few tasks based on specific scenarios that included both the creation of a test as well as completing the test that had been accessed via various devices. We also monitored their reactions. The participants responded that the navigation through the screens was straightforward and that the form fields' meanings were clear. None of the participants had difficulty in creating an assessment, or a section, or an item. It must be emphasized that they agreed (one strongly agreed) that CoSyQTI is a useful tool, that it was generally easy to use and that it is very useful for an author to be able to create personalized assessments. In the near future plans we are creating a module that will allow the authors and the learners to access the learner model and change the value some of its elements. Of course, extensive usability tests have been planned.

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