

# Giving More Adaptation Flexibility to Authors of Adaptive Assessments

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**Abstract.** In this paper, we present AthenaQTI, a tool for authoring personalized assessments, which gives the author significant flexibility in terms of the adaptation that s/he can incorporate in the assessments s/he builds. We focus on presenting the functionality of the authoring environment and the tool's conformance to the IMS-QTI specification, a fact that gives it the advantage of interoperability. Furthermore, we briefly describe the user model and the philosophy of its manipulation.

## 1 Introduction

Adding the adaptation capability to the assessment process in Educational Hypermedia Systems [1] has been proven advantageous, primarily for the reason that users are presented with personalized tests, tailored to their needs, preferences and current knowledge. Furthermore, with adaptive assessments the number of assessment items required can be adjusted, most of the times resulting in fewer items, which implies a shorter, less tedious assessment. There are two techniques used for adaptation within assessments: Adaptive Testing [7] and Adaptive Questions [2].

In Adaptive Testing, the criterion for selecting questions is to match the question's difficulty level with the user's estimated knowledge level. This is because it has been shown that these are the type of questions that are more "informative" in terms of conclusions one can draw on the user's knowledge. The goal is to accurately estimate the user's knowledge. In the Adaptive Questions technique a dynamic sequence of questions is generated depending on user's responses. In this case, several predefined rules, in conjunction with the user's responses, are those that lead to the selection of the question(s) to follow.

In this paper we present a web-based adaptive assessment authoring system, called AthenaQTI (Athena is a Learning Management System where the AthenaQTI tool is going to be integrated). We mainly focus on presenting the functionality of the authoring environment and the tool's conformance to the IMS QTI (Question and Test Interoperability) specification [5]. IMS QTI is a widely adopted and quite stable

specification by the IMS Global Learning Consortium [4]. It proposes the representation of tests in standard XML format, thus allowing interoperability between different assessment tools. Its structure contains elements such as assessments, sections (groupings of questions) and items (formal name for questions).

## 2 The AthenaQTI tool

AthenaQTI is a web-based adaptive assessment authoring system, with which authors/educators are able to create: true/false, multiple choice (single, multiple or ordered response), fill-in the blanks, multiple image choice (single or ordered response) and image hot spot (multiple or ordered response) types of questions. The assessments are represented in XML [5] format, so that they can be easily exported and used by other applications that also conform to IMS QTI specification. Furthermore, authors can open and edit an existing assessment. The assessments are presented to users, who first have to log on, so that their user model is uploaded. Feedback is automatic and can be utilized in several ways. Multimedia objects can be embedded into assessments, so authors can create better interfaces and users can have a more attractive learning environment.

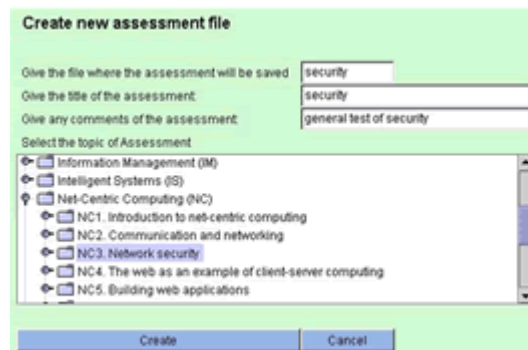


Fig. 1. 'Create new assessment' screen

Assessments are structured exactly as QTI dictates, so that the AthenaQTI tool fully conforms to the specification. Moreover, we have innovated in a number of ways, starting from the use of the *qti-metadata* element, which is used for describing the subject domain that an assessment, section or item refers to. For experimental use, we have carefully analyzed the curriculum structure for studies in computer science provided by IEEE/ACM [3], in order to create a vocabulary that could be widely adopted. This vocabulary assisted us in the task of efficiently describing the topics that an assessment or a section refers to. Fig. 1 shows the screen for creating a new assessment, where the author can select the assessment's topic going down three levels if necessary. Based on the assessment's topic, all sections subsequently created will refer to a sub-topic. By allowing the author to select the appropriate topic for her/his assessment from a given hierarchically structured vocabulary, we alleviate

several future difficulties. A brief discussion of these difficulties requires that we first visit the issue of adaptation in the system. It can be easily understood that in the case that the vocabulary needs to change (e.g. for a different subject domain), the tool's functionality remains the same.

The other innovative aspect of AthenaQTI is that it allows the author to create both adaptive and non-adaptive assessments. Currently, the tool only supports the adaptive questions technique. Items are selected and presented to the user, according to a set of rules that the author creates. These rules take the form of IF-THEN rules, where the condition refers to user model information, and the action refers to the resulting change in the assessment.

When users log on to take the test, they will be described by their personal user model. This will most probably be "carried around" throughout their navigation of other educational (or even other type of) applications as well. As the user model has to form an accurate image of the user, it needs to be updated frequently to include any changes. The core attribute, which is the one (and in some cases the only) used by most Adaptive Educational Hypermedia Systems for adaptation purposes, is the user's knowledge. Knowledge is directly related to educational applications, whose goal is to instruct the user. The clearer the system's view on what the user knows, the better it can adapt. However, apart from knowledge, we keep usage data and stereotype information, that is, from the user model elements that are monitored and changed by the system.

The user's knowledge is updated in our tool, based on the assessments'/sections' topics. The algorithm used to update the user's knowledge is again implicitly given by the author through the rules s/he creates. Examples may be "if the user's score in section C was over 80% then increase the knowledge of the section's topic by factor X". This leads to a user model whose "knowledge" element consists of topics (along with a degree of knowledge) that originate from a very specific vocabulary. In this way, if the user model is later used by a different educational application that is aware of this vocabulary, it will automatically be recognized without difficulty. Imagine if a user model includes "great knowledge" of "Artificial Intelligence" and the application that tries to use it and possibly examine the user's knowledge in "AI" assumes that it does not exist (since it is looking for a match with "AI")!

Usage data includes historical information about the user's performance in the assessment. It is very useful to be able to keep track of the user through a sequence of sections or items. This information is required in cases where the author wants to apply rules such as "if the user performed very well in section A and very poorly in section B, then give a new section with intermediate difficulty level".

Stereotypes are widely used in personalization, especially to overcome the "cold start" problem: how will the user model be initialized. In our tool, we allow the author to define the number of stereotypes s/he considers necessary for the particular assessment, as well as each one's characteristics. Following this, the author is able to employ stereotypes in the rules s/he builds, not only to be applied at the beginning of the assessment, but at any other point.

### 3 Conclusions

In this paper we presented AthenaQTI, a web-based adaptive assessment authoring tool that conforms to the IMS QTI specification. Up to our knowledge, SIETTE [6] is the most relevant tool to which AthenaQTI can be compared. In SIETTE, question selection is based on a function that estimates the probability of a correct answer to a particular question, ultimately leading to an estimation of the student's level of knowledge. The question (amongst the pool of the questions that have not been posed yet) with the highest probability will be posed. Our tool does not use functions to estimate any parameter; rather the author is given the flexibility to express his/her didactical philosophy and methods through the creation of appropriate rules. Furthermore, our tool supports a wider range of question types than SIETTE, which seems to handle mainly multiple-choice. The most important advancement of AthenaQTI lies in the fact that it fully conforms to the IMS QTI standard, making it very powerful since interoperability is currently a vital issue.

AthenaQTI is still in its infancy and we need to proceed to formal testing with real users, since we have only performed laboratory tests focusing on usability and software quality issues. Near future plans concern the evaluation of the adaptation features of the assessments created. This will involve testing with real users, observing and measuring a number of parameters, such as students' performance in non-adaptive and adaptive assessments.

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