An Overview of the IMS Question & Test Interoperability Specification

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Abstract

In May 2000, the IMS released Version 1 of their Question & Test Interoperability (Q&TI) Specifications. Within these specifications are the descriptions of the IMS QTI data structures that are used to provide interoperability between question and test systems used in distributed learning. The key data structures are: Assessment, the basic test unit; Section, a container for groups of sections and items which support a common objective; Item, the fundamental self-contained question/response block within which the individual questions are contained. These specifications now provide a mechanism by which the appropriate vendor and content supplier systems can exchange question and test materials between each other.

Keywords

Question & test, IMS, Interoperability specifications, XML DTD, Item, Section, Assessment.

Introduction

The IMS Question & Test Interoperability (Q&TI) Specifications describe the data structures that are used to provide interoperability between question and test systems. The key data structures are those of:

- Assessment – the basic test unit;
- Section – a container for groups of Sections and Items which support a common objective;
- Item – the fundamental self-contained question/response block within which the individual questions are contained.

It is also possible to exchange multiple Assessments and any combination of Assessments, Sections and Items within a single data structure. The principal aim of the specification is to allow users to import and export their question (termed Items and grouped in Sections) and test (termed Assessments and containing Sections) materials. This requires a clear, concise and unambiguous specification that caters for a wide range of types of questions and test. The IMS QTI specification is constructed such that it is capable of supporting both complex and simple question and test materials, and allows for proprietary extensions that do not compromise the rest of the

specification. The development of the Q&TI specifications has been based upon:

- Ensuring that the most common question types can be easily and readily represented in Extensibility Mark-up Language (XML) as well as ensuring that novel question types can also be readily represented in XML;
- Providing mechanisms through which proprietary features can be supported, by which later versions will be backwards compatible and onto which vendors can easily map their systems;
- Supporting the needs of current vendors while ensuring that newer developments will not undermine the integrity of the specification.

The rest of this paper contains, in Section 2, a description of the IMS QTI Specifications based upon the underlying abstract model and the accompanying XML binding. Section 3 consists of a description of how to use the IMS QTI specifications and in particular a multiple choice example that conforms to the specifications. Section 4 is the conclusion and includes a brief statement of the future work for IMS on its QTI specifications.

The IMS QTI Specifications

The Abstract Model

Any system that supports interoperability between question and test systems must support a wide range of user needs. A schematic representation of such a system and the corresponding user roles is shown in Figure 1.

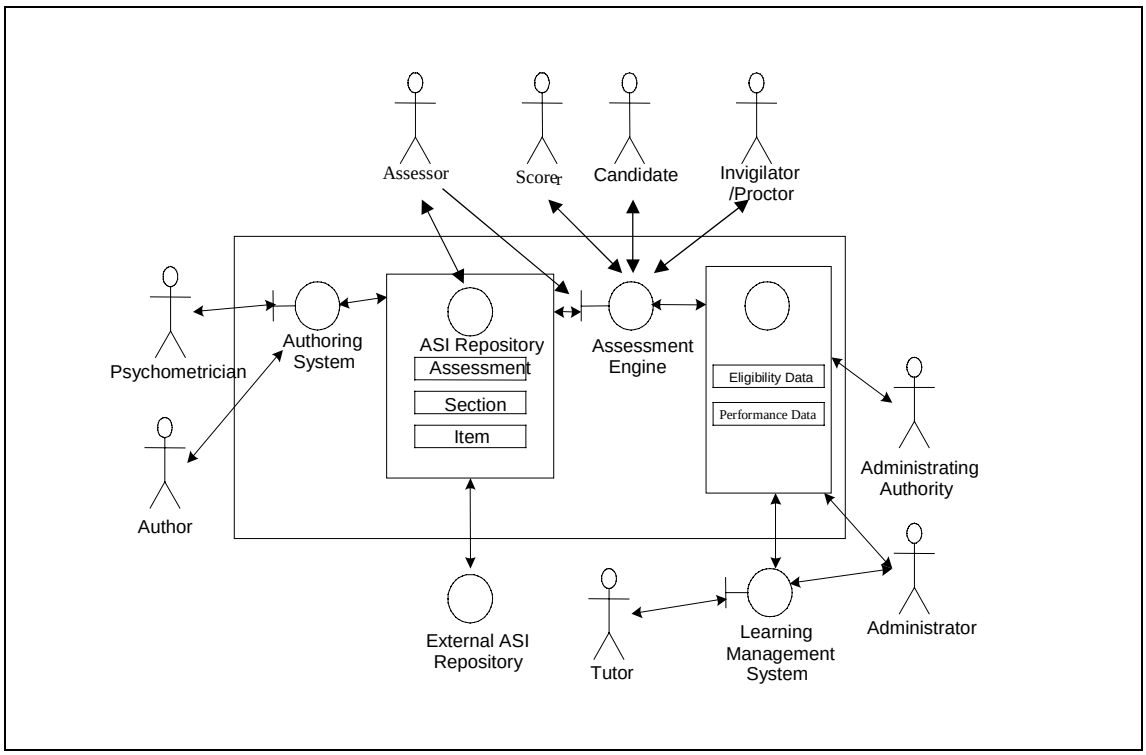

Figure 1 Schematic representation of the system and the users.

The two key features of Figure 1 are:

- The IMS QTI specifications address the exchange of information between 'Assessment, Section & Item (ASI) Repositories'. The internal representation and handling of information within these repositories is beyond the scope of the specifications. V1.0 of the QTI specifications do not address results reporting;
- Each of the user roles requires different types of information. However, this information is derived from a common set of data structures - the questions and test themselves. The IMS QTI specifications adopts this set of 'views' and provides a mechanism by which authors of the Assessments, Sections and Items can provide information specific to each or all of these views.

The IMS approach to the development of distributed learning specifications is to construct the appropriate information model and to then map this model to an XML representation in the form of an XML Document Type Description (DTD). For the QTI specifications the information model was based upon some key work undertaken at ETS (Almond, 1998) in the USA and submitted by them to IMS for adoption. This work was the 'Four Process Model' as shown in Figure 2.

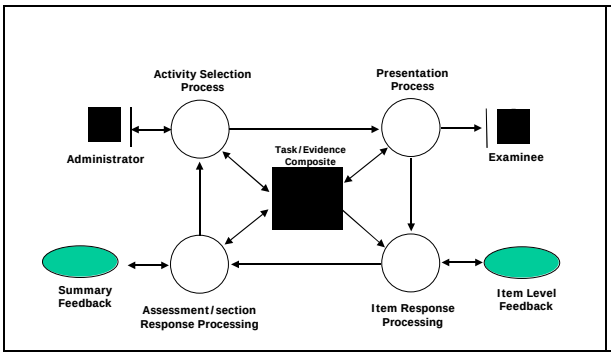

Figure 2 The four process model

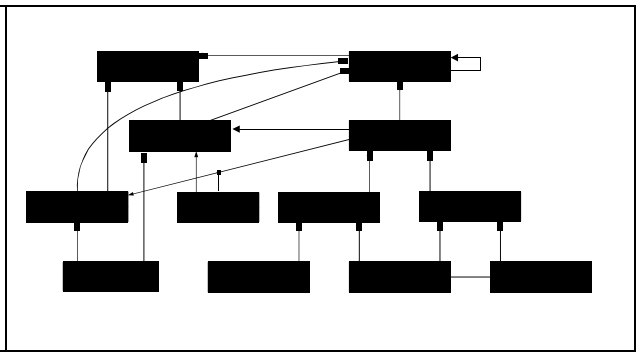

Figure 3 Object oriented representation

The refinement of this four process model, its mapping onto the terminology adopted by the IMS and its representation in an object oriented format is shown in Figure 3. The key features of this approach are:

- The separation of the response processing from the presentation of the questions themselves (an Item can be considered the question and its associated response processing);
- The separation of the response processing for the Item from that of the Section and Assessment. The response processing for the latter two is particularly important for adaptive testing;
- The IMS QTI V1.0 specification does not address the processes of 'Scoring Weight', 'Examinee Record', Activity Selection' and 'Accumulation Processing'. The initial focus was constrained to ensure a specification could be produced quickly and accurately.

XML Binding

The specifications provide the following representation functional capabilities:

- The capability to transfer Assessments, Sections and Items in their entirety or through Universal Resource Locators (URLs). Meta-data descriptions for each of the three fundamental data structures are also described;
- Actor specific views of different types of information, including material, to be presented e.g. objectives and feedback. An actor is a role assumed by a user e.g. candidate, scorer, invigilator, etc;
- A range of presentation formats in which different types of questions can be rendered in different manners e.g. multiple choice as a standard text selection or hot-spots on an image;
- Support for a wide range of contents including video, audio and images as well as the more common text;
- Multiple response processing schemes in which the user responses can be examined using a wide range of logical operators to produce a series of defined scoring consequences;
- Multiple Assessment, Section and Item feedback mechanisms through which feedback can be made in terms of solutions, hints and other responses;
- Support for proprietary extensions that can be used to extend the basic DTD so that vendor specific features can be supported through the specifications;
- Support for additional features to be made available in version 2.0 e.g. dynamic selection and sequencing control of the order in which Sections and Items can be presented to the user.

A consequence of this approach is that the core data structures that can be exchanged using the XML DTD derived from the QTI specifications are shown schematically in Figure 4.

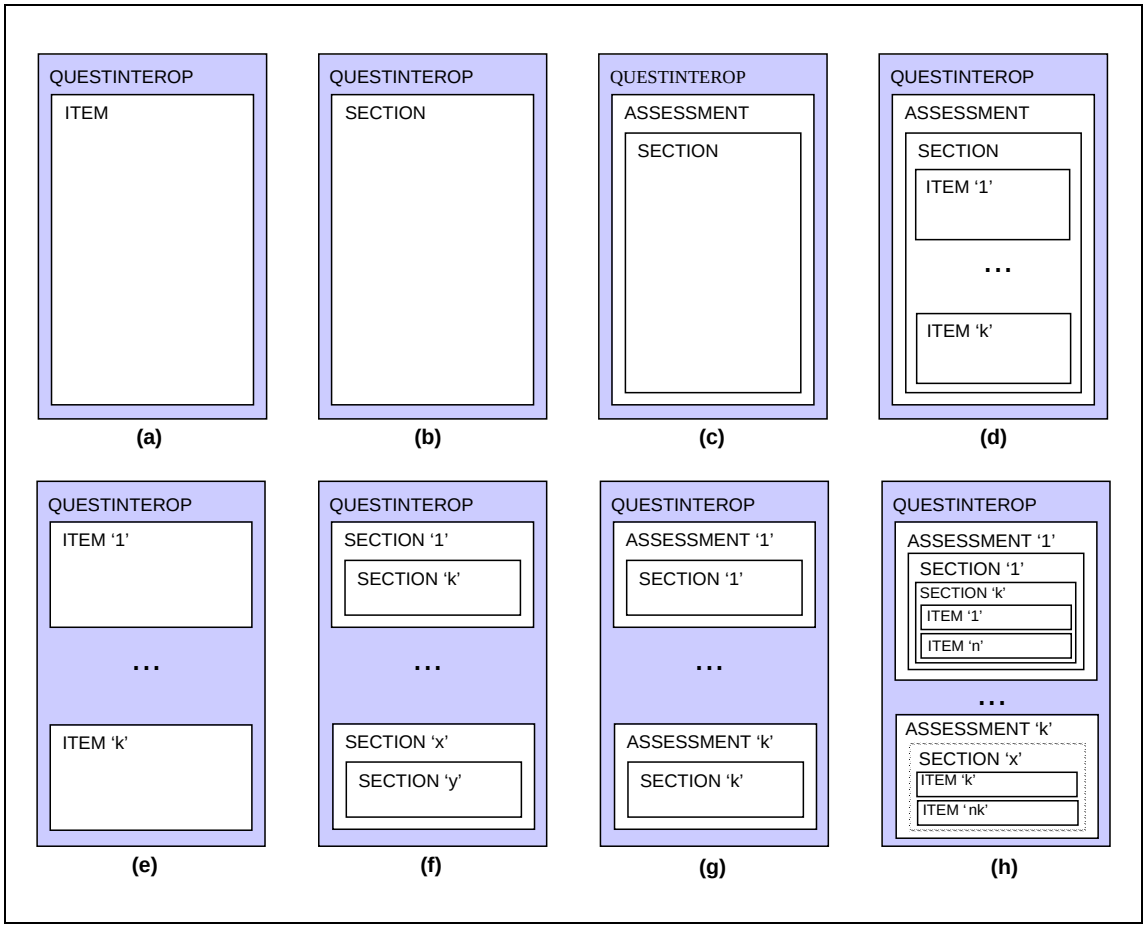

Figure 4 The basic Assessment, Section and Item data structures.

The key features of this interchange capability are:

- The <questinterop> element encapsulates all of the interchanged data structures;
- Any level of nesting of Sections is supported. The Item is the atomic component i.e. the smallest individual structure that can be exchanged;
- An Assessment must always consists of at least one Section (this means that some processing capabilities, such as the selection and sequencing of Sections and Items, will be simplified);
- The combination of Assessment, Section and Item exchange is implementation system dependent.

The primary reason for adopting a single DTD with a multiplicity of uses is that support and maintenance of the interoperability specification is simplified while allowing vendors great flexibility in how they adopt the specification.

Using the QTI Specifications

The Documentation

The specification itself is based upon three documents:

- The Information Model representation is based upon the object oriented Unified Modelling Language (UML) technique plus a tabular listing of the elements and their attributes (Smythe, 2000a);
- The XML Binding takes the UML representation and maps this to an XML implementation. The corresponding DTD file is also reproduced (Smythe, 2000b);
- The Best Practice & Implementation Guide that describes the ways in which different types of Assessments, Sections and Items can be implemented using the IMS Q&TI specifications (Smythe, 2000c).

Together, these specifications are nearly 300 pages in length. In the first instance, it is the Best Practice & Implementation Guide that should be read. This provides a wide range of examples of the questions and their XML realisation and includes a wide range of recommendations of the ways in which the XML should be used to represent Assessment, Sections and Items. As well as the three specification documents and number of other facilities are also available from the IMS web-site http://www.imsproject.org, namely:

- DTDs and XDRs - as set of DTDs and XML Data Representation (XDR) schemas. Each DTD/XDR has a different focus e.g. with/without XML comments, full or core (no support for extensions), etc;
- Examples - a set of sixty examples of commonly used Items, Sections and Assessments (in particular, these are excellent templates for each type of Item). A further thirty examples with known syntactic and semantic errors are also available to enable import testing;
- Tutorials - a set of presentation and support information that is used to brief vendors and other organisations who wish to adopt the IMS QTI specifications;
- Visualisation tool - Question Mark Ltd have supplied a PC-based tool that enables users to view, side-by-side, an Item and its QTI XML implementation.

During the next twelve months this resource kit will be enhanced to include a wider range of examples and other tools as and when they become available e.g. a QTI XML validator.

Multiple Choice Example

The most commonly used type of computer-based questions are multiple choice. An example of such a question is shown in Figure 5 (the educational objective of the question is irrelevant for the sake of this example).

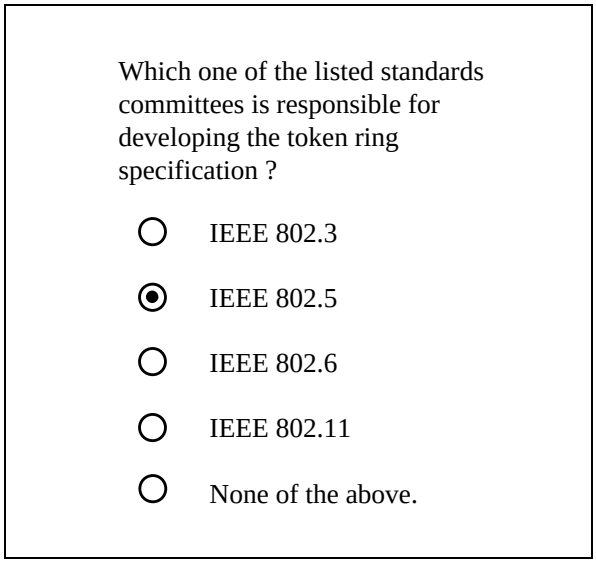

Figure 5 Multiple-choice example

In Figure 5 the actual layout and the usage of the radio buttons are beyond the scope of the specification i.e. these are determined by the system actually rendering the Item.

The specification supports the definition of the actual options (including whether they are shuffled for consecutive presentation) and the question materials them selves.

The accompanying XML is shown in Table 1. This file consists of a single Item description with its presentation material (including the form of rendering), the response processing and the associated feedback.

The key points from the XML implementation are (the shaded bars in Table 1 are guides to the line numbering):

- The basic form of the <item> data structure is <presentation> (lines 3-35), response processing (lines 36-47) and item feedback (lines 48-51);
- The text for the question is given under the <mattext> element (line 5). The corresponding text for the options are given in lines 14, 18, 22, 26 and 30;
- The rendering form is not fixed to the response-type required from the user. In this example the response-type is set as <response_lid> (line 10) i.e. the logical identity of the user selection will be used as the basis for the response processing. The rendering form is set as <render_choice> (line 12) i.e. a standard text based multiple choice question format is to be adopted. An alternative rendering could use hot-spots on an appropriate graphic;
- The displayed choices are to be shuffled (line 12) for each presentation with the exception of the last option that will always be located at the end (line 29);
- Under the response processing the default variable is used to support the scoring (line 37). The correct answer test is made in line 41 by the option shown as label ‘A’ (line 13) from the response presented as identifier “MC01” (line 10). If a correct answer is given then the score variable is set to the value one (line 43);
- The associated feedback for the correct answer is triggered at line 44 and the corresponding feedback material is given in lines 48-51 (inclusive). Other types of feedback could be given e.g. hints, solutions or responses for wrong choices.

Table 1 The XML realisation of a multiple choice example

```
1   <questestinterop>
2       <item title="MC Item" Ident="IMS_V01_I_BasicExample">
3       <presentation label="BasicExample">
4       <material>
5                       <mattext>Which one of the listed standards committees
6                       is responsible for developing the token ring
7           specification ?
8                       <mattext>
9       </material>
10      <response_lid ident="MC01" rcardinality="Single"
11                              rtiming="No">
12          <render_choice shuffle="Yes">
13              <response_label ident="A">
14                  <material><mattext>IEEE 802.3</mattext>
15                              </material>
16              </response_label>
17              <response_label ident="B">
18                  <material><mattext>IEEE 802.5</mattext>
19                              </material>
20              </response_label>
21              <response_label ident="C">
22                  <material><mattext>IEEE 802.6</mattext>
23                              </material>
24              </response_label>
25              <response_label ident="D">
26                  <material><mattext>IEEE 802.11</mattext>
27                              </material>
28              </response_label>
29              <response_label ident="E" rshuffle="No">
30                  <material><mattext>None of the above.</mattext>
31                              </material>
32              </response_label>
33                  </render_choice>
34      </response_lid>
35      </presentation>
36          <resprocessing>
37              <outcomes><decvar  vartype="Integer" defaultval="0"/>
38              </outcomes>
39              <respcondition title="Correct">
40                  <conditionvar>
41                      <varequal respident="MC01">A</varequal>
42                  </conditionvar>
43                  <setvar action="Set" >1</setvar>
44                  <displayfeedback feedbacktype="Response"
45                              linkrefid="Correct"/>
46              </respcondition>
47          </resprocessing>
48          <itemfeedback ident="Correct" view="Candidate">
49              <material><mattext>Yes, you are right.</mattext>
50              </material>
51          </itemfeedback>
52      </item>
53  </questestinterop>
```

The explanation for each of the XML statements is given within the XML Binding (Smythe, 2000b). This example is also given in the Best Practice & Implementation Guide (Smythe, 2000c).

Conclusion

The IMS Question & Test Interoperability specification V1.0 has an extensive set of documentation and support resources. Several question and test system vendors in the UK and USA are already adopting this specification and their conforming products will be commercially available in the near future. Currently, the QTI team within the IMS is developing the scoping document for the V2.0 QTI specifications (these will not be available until May 2001). In V2.0 there are three areas of focus, namely:

- Provision of a results reporting XML binding for QTI interoperability i.e. support for the reporting of user responses and their associated results scoring;
- Provision of an integrated scoring model across the Assessment, Section and Item data structures;
- Support for adaptive testing in the guise of static and dynamic selection and sequencing of Sections and Items;

The IMS have recognised that the issue of legacy must be addressed at the outset of any developing specification. To this end a firm and formal commitment has been made to ensure that the only changes to the V1.0 DTD for Items will be the addition of optional tags for the V2.0 features. Thus, software that is compliant with the V1.0 DTD will be able to import V2.0 Items providing it ignores the optional tags. Also, Items exported from software compliant with the V1.0 DTD will be able to be imported without change to any software that is compliant with the V2.0 specification.

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