

IMS Question and Test Interoperability: An Idiot's Guide

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Why do I need to know about the IMS Question and Test Interoperability specifications?

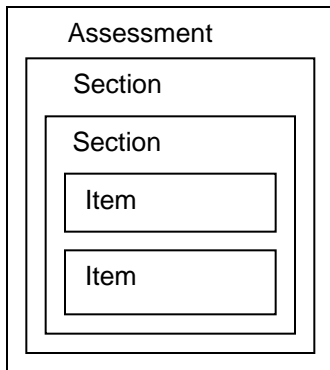
Computers are increasingly being used to help assess learning and knowledge in many educational situations. If you're involved in some way with computer assisted assessment (CAA) it may be helpful for you to know about international developments aimed at making it easier to transfer assessment data such as questions and results between software packages. Here are some of the situations you may find yourself in:

- You're authoring a large bank of multiple choice questions in your subject area. You need to be sure that you're not going to be developing them in a proprietary format which will make the questions unusable if you want to move them to a different system at a later date.
- You're involved in the selection of a CAA system for your institution. You're concerned that learner information and results should be able to be passed with ease between the CAA system and your central computing systems or learning management system.
- You have an interest in online learning and assessment and need to keep up with the latest developments even though you may not be concerned with CAA directly.

Wherever you're coming from, it's unlikely that you're going to have the time to delve into the many pages of the full IMS specifications so this document aims to make the specs more understandable and accessible to you. For many people involved in education an awareness that IMS "compatibility" is beneficial if not essential in the development of online tests or the selection of a CAA system may well be all you need to know. Read on however if you wish to know more.

Give me a brief introduction to IMS QTI.

IMS QTI specifies a way of exchanging assessment information such as questions, tests and results. It uses a language called XML – extensible markup language. XML has become the worldwide standard for storing and exchanging structured data for access over the Internet. It looks similar to HTML, the language behind most web pages. There are many books on XML and a large set of resources and tutorials on the World Wide Web Consortium's site at <http://www.w3.org/XML/> Many assessment systems will continue to store assessment data in their own formats but allow data to be imported from and exported to other systems in the IMS QTI format.



In an attempt to avoid ambiguity, IMS QTI has developed its own terminology. Tests are known as **assessments**. Within an assessment you will of course have one or more questions. To deliver a question you need to know other things such as the score for getting it correct, layout rendering information and what feedback should be given. So questions, with their associated data, are known as **items**.

It's often necessary to group a series of questions within an assessment. This is done using **sections**. You might, for instance have a different section for each subtopic and wish to know the score obtained for each section as well as over the assessment as a whole. In summary, an assessment can contain sections and/or items. A section can contain items and/or other sections.

The person taking the test is called the **participant**. At the end of the assessment a **results report** is generated.

IMS QTI tries not to support a particular pedagogy or method of learning. It makes available a number of commonly used question types or **item types**.

New item types and other proprietary extensions can be added if required by people building systems which implement the specifications.

Item types available:

- Multiple choice
- True false
- Multiple response
- Image hot spot
- Fill in the blank
- Select text
- Slide
- Drag object, drag target
- Order objects
- Match items
- Connect points

There are two core structures within IMS QTI:

- ASI (Assessment, Section and Item) is concerned with the content of the test.
- Results Reporting is concerned with the results from the test.

There are thus two separate specifications which can be implemented independently from each other. Work is currently going on to harmonise these with each other and also with the other IMS specifications.

QTI Lite

QTI Lite is a cut down version of the specifications which was developed in response to concerns that they were becoming increasingly complex. It deals with items only; sections and assessments are not included. The only item type to be implemented is multiple choice single response. The response processing for this is specified but has been simplified. There is support for text and images but not video or audio. Most automated testing contains simple multiple choice questions; QTI Lite is available for vendors who wish to implement very simple testing systems only.

Results reporting

Results in QTI are specific to a single participant. They can however contain multiple instances such as the results of several assessments. There are four constructs within the results reporting data model:

- **Summary** contains data such as the maximum score and how many attempts have been made.
- **Assessment** corresponds to the construct in the ASI model and can incorporate sections and items.
- **Section** – as in the ASI model.
- **Item** – as in the ASI model.

Each of these constructs contains a **context** which specifies details such as the name of the participant, their ID number and institution.

What does IMS QTI look like?

IMS QTI code is written in XML and, although it is normally read only by computer programs, it can be understood by humans. It's a bit similar to HTML, the language behind web pages. It may help you to understand what is going on by examining the following bit of XML for a simple True/False question. This example does not deal with response processing.

```
<questestinterop>
  <item ident="IMS_example_X09678">
    <presentation label="example_X09678">
      <material>
        <mattext>Glasgow is the capital of Scotland.</mattext>
      </material>
      <response_lid ident="TF01" rcardinality="Single" rtiming="No">
        <render_choice>
          <response_label ident="T">
            <material><mattext> True </mattext></material>
          </response_label>
          <response_label ident="F">
            <material><mattext> False </mattext></material>
          </response_label>
        </render_choice>
      </response_lid>
    </presentation>
  </item>
</questestinterop>
```

Further examples can be found in the ASI Best Practice and Implementation Guide (see Appendix 1).

What is IMS and how are the IMS QTI specifications developed?

The IMS Global Learning Consortium, Inc. (IMS) is defining specifications to allow distributed learning applications and services to work together or *interoperate*. Activities include searching for and using educational content, monitoring the progress and performance of learners, and transferring student records between systems. IMS has educational, commercial and governmental members and is funded by their membership fees.

The IMS Question and Test Interoperability Working Group is comprised of individuals from various member organisations and has face to face meetings and conference calls on a regular basis. An online forum is also used for members to communicate. The main participating organisations include Question Mark, ETS, JISC/CETIS, UCLES, Fretwell Downing and Galton Technologies. Over 30 other organisations have participated in the meetings, forum and conference calls. The specifications go through a number of iterations resulting in Public Draft Specifications which are presented to the 25 members of the IMS Technical Board who vote to decide whether or not they should be adopted. If so, they are released as Final Specifications.

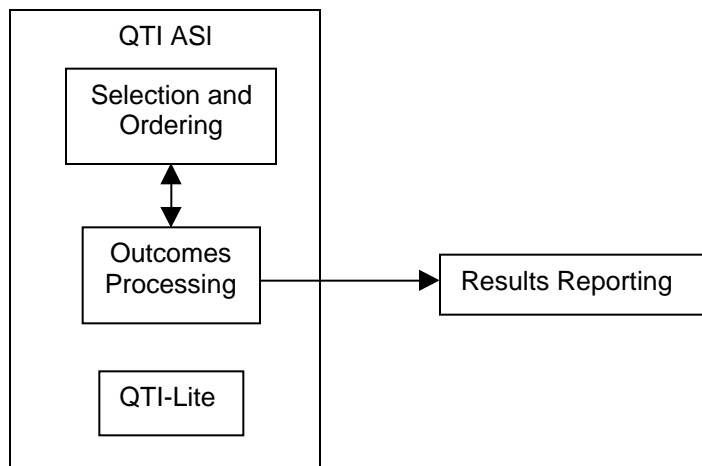
What are the various specification documents?

Version 1.0 (Final Specification) of the spec was released in May 2000, version 1.1 (Final Specification) in March 2001. The current version, v1.2 adds considerable new functionalities as below, shown with the relevant specification documents respectively:

- the selection and ordering of sections and items - ASI Selection and Ordering
- scoring roll-up in sections and assessments, from question scores to test scores - ASI Outcoming Processing
- reporting assessment results - Results Reporting

With a few exceptions, all versions are backwards compatible so that systems and materials developed to one specification will work with future versions. There are nine separate documents within the current QTI specification. If this paper has whetted your appetite and you wish to delve further into QTI you should start with the Best Practice & Implementation Guide. You may also wish to look at the QTI Lite specification. Both of these contain many examples of how to use the specifications.

Based on its two main core data structures, the IMS QTI specification contains two separate specifications: ASI and Results Reporting, plus a light-weight version or subset of the QTI spec for introductory implementation – the IMS QTI-Lite Specification. The ASI Specification is comprised of five documents in total: *ASI Information Model Document*, *ASI XML Binding Document*, *ASI Best Practice and Implementation Guide*, *ASI Selection and Ordering Specification*, *ASI Outcome Processing Specification*. The first three documents show the specification from various perspectives (best practice, technical etc.), while the last two elaborate parts of the specification.



The Results Reporting Specification is comprised of three documents: *Results Reporting Information Model Document*, *Results Reporting XML Binding Document*, *Results Reporting Best Practice and Implementation Guide*.

Further details of the specification documents are included in Appendix 1.

Where does IMS QTI fit in with other IMS specs?

The IMS QTI spec is related to, and can be used in conjunction with other IMS specifications. The specification is intended to be consistent with these in order to reduce redundancy and confusion between specifications. The related specifications are:

- **IMS Meta-data Specification** – Meta-data is used at various points in the QTI spec: for describing and cataloguing assessment items (authors, keywords, subject domain, etc.), for selecting and ordering assessment (only ‘easy’ or ‘short-duration’ question type). The spec shares a number of common data object elements with the IMS Meta-data specification. In addition, a set of unique, QTI-specific meta-data extensions are also used and these are defined within the QTI specifications themselves.
- **IMS Content Packaging Specification** – The Content Packaging spec provide a consensus for describing, organising and encapsulating a set of learning objects in ‘IMS’ packages. IMS packages can be recognised by, and therefore exchanged among various learning

environments, editing and delivery tools. Assessment is a type of learning object; the QTI data model is therefore a subset of the Content Packaging data model i.e. QTI Assessments, Sections and Items can be defined as a type of content and their XML can be inserted into a Content Packaging instance.

- **IMS Learner Information Packaging Specification** – this specification can be used as an alternative results reporting mechanism.

What tools are available to implement the QTI spec?

IMS QTI is based on XML. On a very basic level, you could 'hand-code' the XML elements of QTI assessment using a text editor or a special purpose XML Editor such as XMLSpy. Given the complexity of the specifications, this approach is only appropriate for QTI and XML developers and experts. Most people will prefer to use high-level authoring tools and systems which automatically generate assessments in QTI format. Various virtual learning environment vendors have a commitment to IMS and incorporate assessment in their tools. It should be stressed that things are at a relatively early stage and many of these tools are still under development. Others claim to be QTI "compliant" but this has not been independently verified.

Virtual Learning Environments with QTI import and/or export facilities

Blackboard (www.blackboard.com)

JLE, ESSI (www.jle.net)

Learning Environment, Fretwell-Downing Education (www.fdgroupp.com/fde/le)

Oracle iLearning, (www.oracle.com/ilarning)

WebCT (www.webct.com)

Commercial Assessment Tools with QTI import and/or export facilities

Can Studios (www.the-can.com) (not yet available)

Calypso, Experient eLearning Technologies (www.experient.com) (not available)

e-Test 3, RIVA Technologies, Inc (www.riva.com)

Granada Testwise

IMS Assesst Designer xDLS, xDLSoft (www.xdlsoft.com/ad/)

LiveLearning, ID Technology (www.livelearning.it)

Precision Suite of Tools, (www.iisprecisionstaffing.com)

Question Mark Perception (www.questionmark.com)

QuizAuthor, Niall Barr (www.nbsoftware.com) – Shareware

R&D Assessment Tools with QTI import and/or export facilities

Ultimate Assessment Engine, Strathclyde University (cvu.strath.ac.uk/ae)

E3AN, Southampton University (www.e3an.ac.uk)

Leeds University, Graham Smith

Luton University, Ray Harper

UCCLES, Steve Lay

The following provides an overview of several CAA systems supporting IMS QTI. Further details and other tools can be found in the IMS Product Directory:

<http://www.msglobal.org/direct/directory.html>

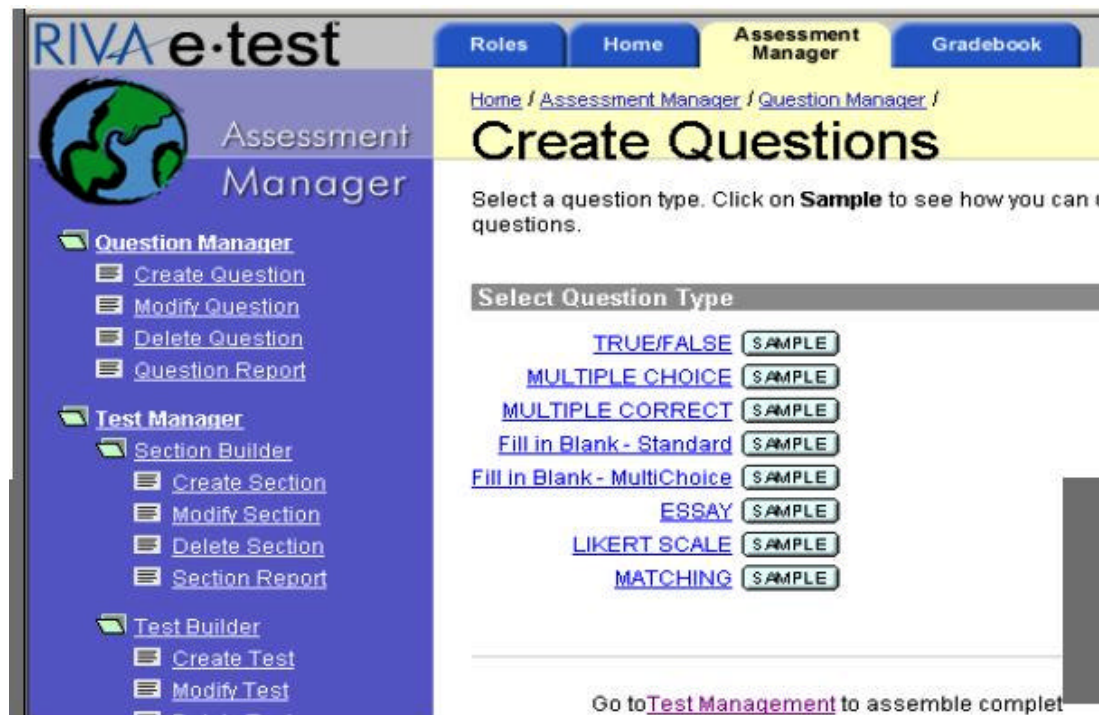
e-Test 3, RIVA Technologies Inc (www.riva.com)

e-Test is a comprehensive CAA system from Riva, a company based in Texas, USA. It is "industrial-strength" and supports a diverse client-base including Fortune 500 companies, as well as small businesses. e-Test offers two types of CAA solutions: Web-based hosting services where questions and assessments are hosted on the company's server, and on-site solutions where the system is installed on client sites.

The system relies on Java client server technology, Oracle or IBM database (depending on client preference), and a question engine (SQL Server 2000) for database querying tasks. Both solutions (hosting and on site) use a web browser, e.g. Netscape 4.X+ IE 4.X+ (on Linux,

Windows and Sun Solaris platforms) as a front-end. This means end-users do not need to download additional local software and plugins.

With the system you can author and view 8 types of questions: Multiple Choice, Multiple Response, True/False and Yes/no, Fill-in-the-blank, Short Answer, Essay, Likert Scale, Matching, see the figure below. All question types support the use of multimedia. Advanced HTML features can be used in all question types.



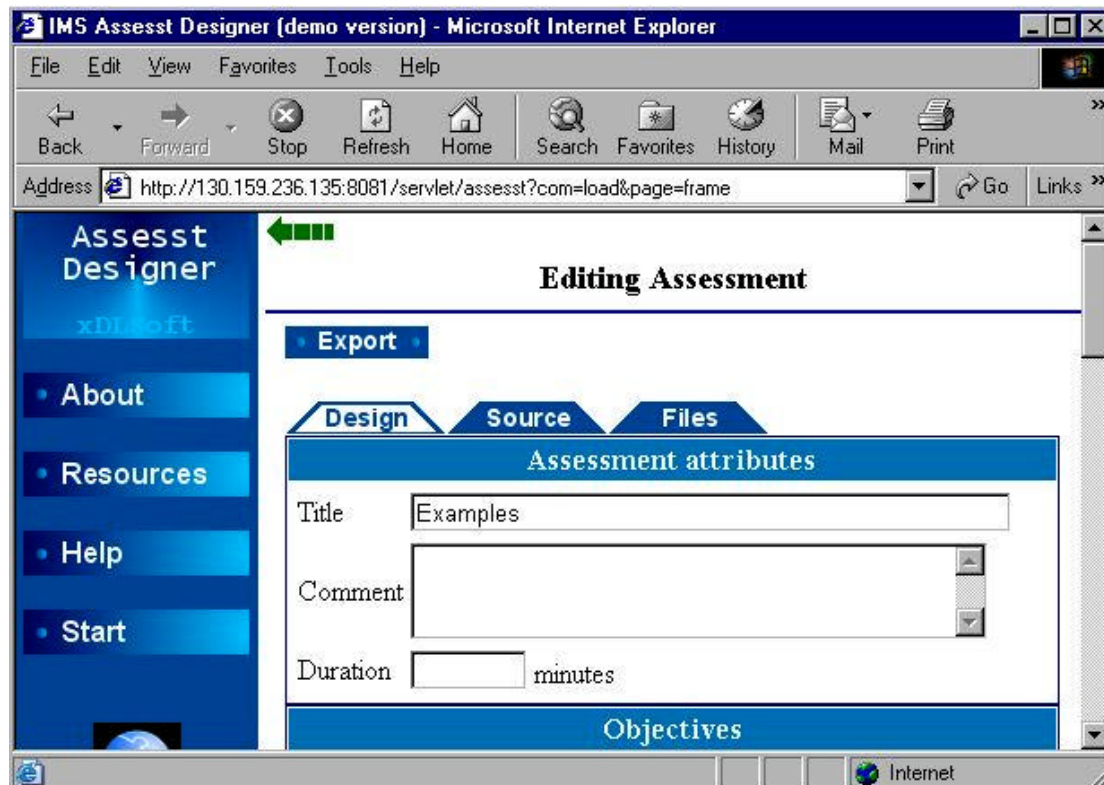
Assessment administration and deployment are also facilitated by the system. This makes it comprehensive and on par with other leading CAA systems in the market such as QuestionMark's Perception (describe below). Other features include results reporting and question selection and ordering, e.g. by level of difficulty. e-Test claims to support IMS QTI and facilitates the importing and exporting of IMS QTI assessments generated by other systems. Depending on the type of services, the pricing of e-Test varies. The hosting service cost is fixed on call for quotation, while the on-site solution requires site hardware configuration and users analysis before the cost can be decided.

IMS Assesst Designer xDLS, xDLSoft (www.xdlsoft.com/ad/)

IMS Assesst Designer is an authoring tool for creating IMS QTI (version 1.1) assessment. The tool is based on a client-server architecture in which the authoring service is provided via a web server running on running Windows 98, Windows NT or 2000; question authors can create, modify, delete and rearrange questions using a web browser, i.e. Microsoft Internet Explorer 5.0 and higher. The system currently does not support servers on other platforms, though you can access the authoring service using Internet Explorer on Mac and Unix.

The system supports 4 types of questions: multiple choice, multiple response, matching, numerical and string fill-in-black which can be exported and imported in IMS QTI zipped format. Compared to e-Test, Assesst Designer is on a much smaller scale. Although it has the facility to 'test run' assessment and provides simple feedbacks and results scoring, it is not intended for formal deployment of assessment which requires other processes such as user registration,

security and selection and ordering. You can use the software as a special purpose tool for authoring and editing IMS QTI. As shareware it costs US \$27 to register.



Question Mark Perception (www.questionmark.com)

Among all available CAA systems, Question Mark Perception is by far the most advanced and fully-fledged system. It comes in two packages "Perception for Web" and "Perception for Windows". Both packages contain similar modules and features; the former allows authoring, administration and reporting to be accomplished via a web browser (similar to the systems previously described in this guide), while the latter works solely in a Windows environment. Perception currently supports Windows PC only. However, in the web version, once you have the system installed on a server on Windows PC, you can use web browsers on any platforms.

Authoring in Perception is accomplished on two levels: Question and Assessment, each supported by a dedicated 'manager'. In Question Manager, up to 20 types of questions can be created using a typical form filling editor or 'step-by-step' wizards. For a list of supported question types, see <http://www.questionmark.com/us/perception/index.htm#qtypes>. Assessment manager supports the selection and grouping of questions (see above) from databases (Microsoft Access or Oracle), using parameters such as 'topic'. Question manager also provide importing and exporting facilities for IMS QTI assessment. In addition, it contains a Report Manager supporting 9 different styles of reporting and a deployment engine which allows assessments to be published on CDs, standalone or via a network. QuestionMark directs you to their website for pricing options. The top of the range Perception system is implemented using an Oracle database.

Test Maker in LiveLearning, ID Technology (www.livelearning.it)

LiveLearning is a web-based LMS featuring a basic question editor called 'Test Maker'. It is accessible via a web browser and supports 5 standard types of question: fill in the blanks, multiple fill-in the blanks, true-false, multiple choice, multiple response. The question editor however does not support importing and exporting of assessment.

Where can I find out more information?

CETIS Assessment Special Interest Group

The Centre for Educational Technology Interoperability Standards (CETIS) has an Assessment Special Interest Group with regular meetings, dissemination events and a mailing list. See www.cetis.ac.uk/assessment.

IMS QTI Working Group

The IMS Global Consortium's QTI Working Group can be found at www.imsproject.org. All the crucial documentation can be found here.

References

IMS Global Learning Consortium (2000) IMS Question & Test Interoperability: Best Practice & Implementation Guide, Final Specification Version 1.01

IMS Global Learning Consortium (2001) IMS Question & Test Interoperability: ASI XML Binding Specification, Final Specification Version 1.1

Oracle iLearning (2001) eClass IMS Basic Training: Question and Test Interoperability, <http://ilearning.oracle.com/>

Smythe, C & Roberts, P. (2000) An Overview of the IMS Question & Test Interoperability Specification

Appendix 1: A Guide to the IMS QTI Specification Documents

ASI Information Model Document

The QTI ASI Information Model document is comprised of several sections. The first section contains use cases (scenarios relating to CAA) describing the underlying usage and the structures of the core data model, i.e. the Assessment, Section and Item (ASI) model. The basic information model itself is outlined in conceptual terms by using a tabular layout of the Assessment, Section, and Item objects in terms of their elements, sub-elements and attributes. The QTI specific meta-data, which is used to catalogue ASI objects, is also described. In addition, the document contains a conformance statement to be used by vendors who plan to implement the specification.

ASI XML Binding Document

The XML Binding document is a technical document which describes the implementation of the ASI information model in XML, the language chosen to represent various data structures of the spec. XML is introduced by outlining XML basics. This document which contains details and examples of XML schemas (the blueprints required for any XML data structure), should be used by developers for implementing IMS QTI.

ASI Best Practice and Implementation Guide

This document is intended to provide an overall understanding of the ASI specification, the relationship of this specification to other IMS specifications, and a best practices guide derived from experiences of those using the specification. It also contains approximately 80 actual examples showing how the QTI ASI spec. can be applied. If you are new to IMS QTI, you should start with the Best Practices & Implementation Guide. You could also make use of the example as starting templates for any QTI implementation.

ASI Selection and Ordering Specification

Selection and Ordering is part of the overall ASI model. This document contains a further detailed description of how the order in which Sections and/or Items are presented can be controlled.

The selection and ordering process is a two-stage operation in which the assessment items can be selected according to some defined criteria and presented in an order specified, for instance, sequential or random. Examples of selection criteria involve the use of item number, logic/condition (selection of one item is depending on the selection of others), meta-data such as question types, difficulty and duration.

This document also includes the relevant information model, XML binding and best practices guidance (you should be read this section first); it (the whole document) should be read in the context of the core ASI documents.

ASI Outcomes Processing Specification

Outcomes Processing is also part of the overall ASI model. The specification contains the further details description of how the aggregated scores at the Assessment and Section levels can be derived. These scoring outcomes are based upon the sub-sections and/or assessment items. A wide range of scoring algorithms (6 in total, with more planned in the later release of the spec.) such as 'number of right answers' and 'percentage correct' is supported through the use of a predefined set of parameterised instructions. In addition to the built-in algorithm, the specification also allows you to specify proprietary scoring algorithms.

This document also includes the relevant information model, XML binding and best practices guide (you should be read this section first); the whole document should be read in the context of the core ASI documents. Each of the supported scoring algorithms is explained in its own appendix.

Results Reporting Information Model Document

The QTI Results Reporting Information Model document is comprised of several sections. The first section contains use cases in which the underlying usage, core data structures of the results to be reported are described. The basic information model itself is outlined in conceptual terms by using a tabular layout of five main elements of the spec: *the context, summary, Assessment results, Section results, and Item results* . The corresponding meta-data, which are used to catalogue these objects, are also described. In addition, the document contains a conformance statement to be used by vendors who plan to implement the specification.

Results Reporting XML Binding Document

The XML Binding document is a technical document that describes the implementation of the Results Reporting information model in XML, the language chosen to represent various data structures of the spec. XML is introduced by outlining XML basics. This document contains details and examples of XML schemas (the blueprints required for any XML data structure). It should be used by developers wishing to implement IMS QTI.

Results Reporting Best Practice and Implementation Guide

This document is intended to provide an overall understanding of the results reporting specification, the relationship of this specification with other IMS specifications including the QTI ASI, and a best practices guide derived from experiences of those using the specification. It also contains actual examples showing how the results reporting spec. can be applied. If you are a new user of this spec., you should start with the Best Practices & Implementation Guide. You could also make use of the example as starting templates for quick implementation of QTI.

QTI Lite Specification

This document describes the components that are required to construct the simplest form of a QTI-compliant system. QTILite only supports multiple-choice questions including the true/false questions. It also limits the rendering form to the classical one response from a set of choices.

Multiple Items can be exchanged in a single QTI-XML instance; Assessments and Sections parts of the overall ASI Spec. are not supported. The QTILite specification is a standalone document in that none of the others document described above, are required to understand and construct QTILite-compliant systems. QTILite was introduced as an aide to understanding the QTI specification and is not intended for wide-spread long-term adoption.