IMS Question and Test Interoperability: ASI Information Model Specification

Version 1.2 Final Specification

IPR and Distribution Notices

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the specification set forth in this document, and to provide supporting documentation.

IMS takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Information on IMS's procedures with respect to rights in IMS specifications can be found at the IMS Intellectual Property Rights web page: http://www.imsglobal.org/ipr/imsipr_policyFinal.pdf.

If you wish to distribute this document or use this document to implement a product or service, you must complete a valid license registration with IMS and receive an email from IMS granting the license. To register, follow the instructions on the IMS website: http://www.imsglobal.org/specificationdownload.cfm.

This document may be copied and furnished to others by Licensee organizations registered on the IMS website provided that the above copyright notice and this paragraph are included on all such copies. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to IMS, except as needed for the purpose of developing IMS specifications, under the auspices of a chartered IMS work group.

Use of this specification to develop products or services is governed by the license with IMS found on the IMS website: http://www.imsglobal.org/question/qtiv1p2/qtiv1p2speclicense.html.

The limited permissions granted above are perpetual and will not be revoked by IMS or its successors or assigns.

THIS SPECIFICATION IS BEING OFFERED WITHOUT ANY WARRANTY WHATSOEVER, AND IN PARTICULAR, ANY WARRANTY OF NONINFRINGEMENT IS EXPRESSLY DISCLAIMED. ANY USE OF THIS SPECIFICATION SHALL BE MADE ENTIRELY AT THE IMPLEMENTER'S OWN RISK, AND NEITHER THE CONSORTIUM, NOR ANY OF ITS MEMBERS OR SUBMITTERS, SHALL HAVE ANY LIABILITY WHATSOEVER TO ANY IMPLEMENTER OR THIRD PARTY FOR ANY DAMAGES OF ANY NATURE WHATSOEVER, DIRECTLY OR INDIRECTLY, ARISING FROM THE USE OF THIS SPECIFICATION.

Document Name: IMS Question and Test Interoperability: ASI Information Model Specification
Date: 11 February 2002

Table of Contents

1. Introduction

1.1 Question & Test Interoperability Overview

The IMS Question & Test Interoperability (QTI) specification describes a basic structure for the representation of question (item) and test (assessment) data and their corresponding results reports [QTI, 02i]. Therefore, the specification enables the exchange of this item, assessment and results data between Learning Management Systems, as well as content authors and, content libraries and collections. The QTI specification is defined in XML to promote the widest possible adoption. XML is a powerful, flexible, industry standard markup language used to encode data models for Internet-enabled and distributed applications. The QTI specification is extensible and customizable to permit immediate adoption, even in specialized or proprietary systems. Leading suppliers and consumers of learning products, services and content contributed time and expertise to produce this final specification. The QTI specification, like all IMS specifications, does not limit product designs by specifying user interfaces, pedagogical paradigms, or establishing technology or policies that constrain innovation, interoperability, or reuse.

This document, the IMS QTI Assessment, Section and Item Information Model, is comprised of several sections. The first section contains use cases in which the underlying usage, processing control, and core data structures of the QTI specification are described. It also details the taxonomy of responses, as well as their relationship to questions type and the larger group of 'items'. 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 Item, Section, and Assessment 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; we have adopted a descriptive approach to conformance thereby enabling vendors to implement subsets of the full specification.

1.2 Scope & Context

This document is the third revision of the IMS Question & Test Interoperability (QTI): ASI Information Model Specification. As such it will be used as the basis for the production of the following documents:

- IMS Question & Test Interoperability: ASI XML Binding Specification v1.2 [QTI, 02b];
- IMS Question & Test Interoperability: ASI Best Practice & Implementation Guide v1.2 [QTI, 02c];
- IMS Question & Test Interoperability: QTILite Specification v1.2 [QTI, 02h].

This requirement has been derived from the agreed IMS Q&TI V1.2 Scoping document [QTI, 00]. This document should also be read in conjunction with the:

- IMS Question & Test Interoperability: ASI Selection & Ordering v1.2 [QTI, 02d];
- IMS Question & Test Interoperability: ASI Outcomes Processing v1.2 [QTI, 02e].

V1.0, V1.01 and V1.1 Items are compatible with this V1.2 specification. Previous definitions of Assessments and Sections are **not** compatible with this version.

1.3 Structure of this Document

The structure of the rest of this document is:

2. Specification Use Cases:	The underlying usage, processing control and data structures comprising the question and test interoperability system;
3. Questions, Items and Responses:	The taxonomy of responses and their relationship to question/items;
4. Basic Information Model:	The underlying question and test interoperability information model;
5. Conceptual Description of the Data Objects:	The detailed description of the Assessment, Section and Item objects in terms of their elements, sub-elements and attributes;

6. Metadata Descriptions:	The item, section and assessment metadata descriptions;
7. Conformance Statement	The definition of Conformance to be used by vendors.

1.4 List of Abbreviations

ASI	Assessment, Section and Item
FIB	Fill In Blank
IHS	Image Hot Spot
LDS	Logical Data Structure
LMS	Learning Management System
QTI	Question & Test Interoperability
UML	Unified Modelling Language
XML	Extensible Markup Language

1.5 References

[ETS, 99]	*A Sample Assessment Using the Four Process Framework*, R.Almond, L.Steinberg and R.Mislevy, ETS Working Paper, October 1998.
[IMS, 01]	*IMS Persistent, Location-Independent Resource Identifier Implementation Handbook*, M.McKell, Version 1.0, IMS, April 2001.
[QTI, 02a]	*IMS Question & Test Interoperability: ASI XML Binding Specification*, C.Smythe, E.Shepherd, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 02b]	*IMS Question & Test Interoperability: ASI Best Practice & Implementation Guide*, C.Smythe, E.Shepherd, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 02c]	*IMS Question & Test Interoperability: ASI Selection & Ordering Specification*, C.Smythe, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002
[QTI, 02d]	*IMS Question & Test Interoperability: ASI Outcomes Processing Specification*, C.Smythe, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 02e]	*IMS Question & Test Interoperability: Results Reporting Information Model*, C.Smythe, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 02f]	*IMS Question & Test Interoperability: Results Reporting XML Binding*, C.Smythe, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002
[QTI, 02g]	*IMS Question & Test Interoperability: Results Reporting Best Practice & Implementation Guide*, C.Smythe, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 02h]	*IMS Question & Test Interoperability: QTILite Specification*, C.Smythe, E.Shepherd, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 02i]	*IMS Question & Test Interoperability: Overview*, C.Smythe, E.Shepherd, L.Brewer and S.Lay, Final Specification, Version 1.2, IMS, February 2002.
[QTI, 00]	*IMS Question & Test Interoperability Version 1.x Scoping Statement*, C.Smythe and E.Shepherd, Version 1.0, IMS, November 2001.
[QTI, 99]	*IMS Question & Test Interoperability Requirement Specification*, C.Smythe, Version 1.0, Draft 0.3, IMS, November 1999.
[RFC1521]	*MIME (Multipurpose Internet Mail Extensions) Part One: Mechanisms for Specifying and Describing the Format of Internet Message Bodies*, N.Borenstein and N.Freed, IETF, IETF Request for Comment, September 1993.

[RFC1630] *Universal Resource Identifiers in WWW: A Unifying Syntax for the Expression of Names and Addresses of Objects on the Network as used in the World-Wide Web*, T. Berners-Lee, IETF, IETF Request for Comment, June 1994.

2. Specification Use Cases

The Requirement Specification [QTI, 99] introduced the base QTI system architecture and the v1.x scoping document [QTI, 00] was responsible for extending this requirement. The IMS QTI underlying process components (circles) and data structures (thin rectangles) and the participants (stick-people) are shown in Figure 2.1.

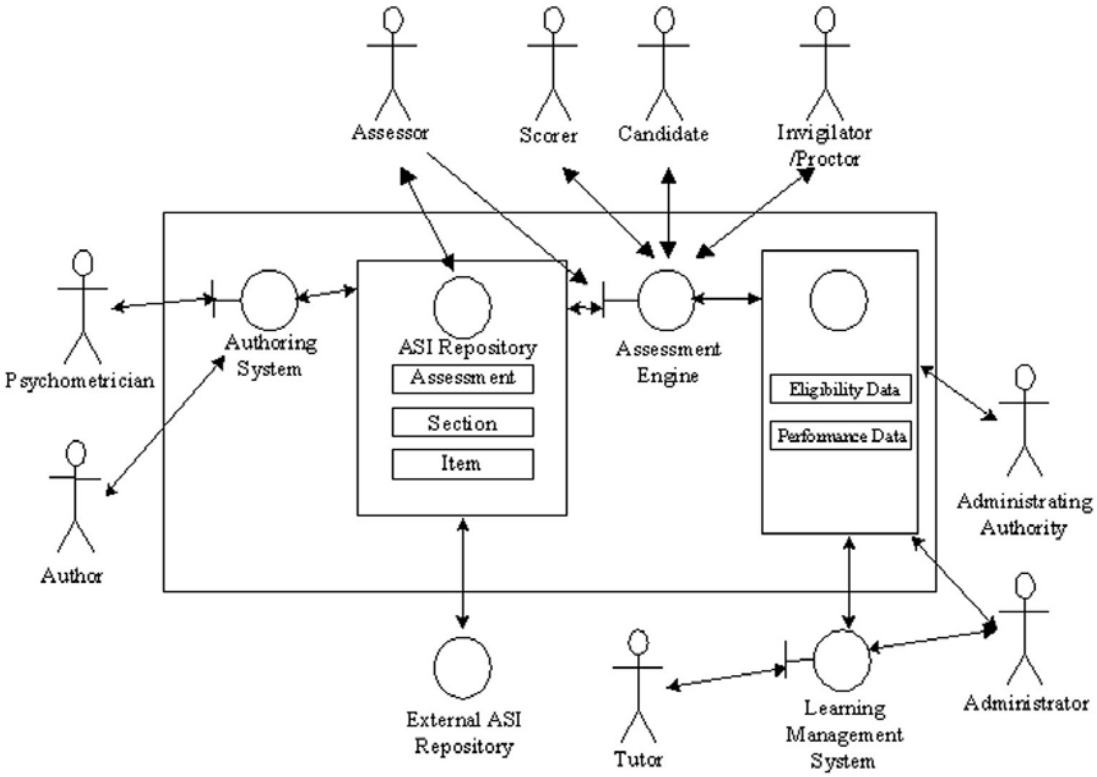

Figure 2.1 Assessment system component representation.

The key components of the assessment system are:

- Authoring system – the process that supports the creation and editing of the Assessments, Sections and Items (ASIs);
- Assessment engine – the process that supports the evaluation of the responses in terms of producing ASI related scores, evaluation and feedback;
- Learning management system – the process/system which is responsible for the management of the entire learning architecture;
- Candidate data repository – the database of the candidate specific information. The eligibility content is outside of the scope of the QTI specifications whereas the Examinee record information is addressed by the IMS QTI Results Reporting specifications [QTI, 02e], [QTI, 02f], [QTI, 02g];
- ASI repository – the database of the local ASIs;
- External ASI repository – the databases of the external ASI that will be imported through the use of the QTI specifications.

The Version 1.2 IMS QTI: ASI Information Model is concerned with the specification of the *ASI* data structures. Throughout the detailed information model description the term 'view' will be used to describe the perspective of the system as perceived by a *Participant*. As such different participants will have access to similar functions but the content will reflect the nature of the actor.

A range of Use-cases are possible but only three are presented as examples of this current version of the specification:

- Authoring – creation and editing of the ASIs;
- High-stakes Assessment – candidate examination;
- Low-stakes Assessment – tutor support using the ASIs;
- Content-based evaluation – interactive native content based upon QTI-XML.

2.1 Authoring Use-Case

The sequence of processing, with respect to the ASI data structures is:

- The Author launches the Authoring System;
- The *Author* then creates, or modifies, *Items*, *Sections* and/or *Assessments*. These are then exported using this QTI specification and stored in some external database. The ASI data structures can consist of complex groups based upon multiple *Assessments* and/or multiple recursive *Sections* and/or multiple *Items*;
- The Author may import ASIs that will be used to create the new ASIs. These imported ASIs will also conform to the QTI specifications;
- One of the key responsibilities of the author is to determine the response-type and to map this to the appropriate rendering type. This mapping will depend upon the educational objective of the Item. Similarly, the Section and/or Item groupings, selection and ordering will be dependent upon the educational objectives of the ASI unit. The author is also responsible for supplying the actor view specific information – this is important as it will help the users appreciate how the material is to be used;
- The Psychometrican sets Item weights and parameters in the Assessment and may reference Assessment records (pre-test data);

2.2 Assessment Use-Cases

2.2.1 High-Stakes Assessment Use-Case

The *Assessment Engine* process is responsible for realizing this activity (the basic processing scheme is derived from the ETS framework [ETS, 99]). It is important to note that the internal operation of the *Assessment Engine* is beyond the scope of this specification. This use-case is included because it justifies some of the structural components that must be defined within the ASIs. The Assessment Engine's assessment processing sequence is:

- The *Assessor* constructs/selects the ASIs to be used throughout the assessment procedure. These ASIs will be stored in some internal database and as such the dynamic sequencing information must be self contained;
- The assessment is activated by the *Candidat*e and this activity is monitored by the *Invigilator/Proctor*. The *Candidate* responds to the ASIs and produces a set of *Responses*, again stored internally. The *Responses* are the set of Item identifiers plus associated information that accurately characterize the response;
- Either synchronously or asynchronously each *Response* will be evaluated by the *Response Processing* to construct the initial score (the scoring information is a part of the *Item* data structure). This scoring requires the usage of a set of *Evidence Rules* that are used to define the key parameters through which the responses are to be evaluated. The resulting Item evaluation is stored in the *Outcomes* data structure. If an Item is to be reused in two different assessments (e.g. high-stakes selection or low-stakes tutoring), then the same content with different response processing and accumulation can be used. In this case, Authoring Systems would be responsible for changing the associated outcome description and response processing, as well as accumulation data and parameters;

- *Accumulation Processing* now takes place in which the *Outcomes* are analyzed and collated in terms of the weighting, etc. defined as part of the *Section* data structures. This information is stored as part of the *Assessment Record*;
- The final stage of assessment processing is the *Assessment Accumulated Process* in which the *Assessment Record* is further processed with respect to the *Assessment* data structure level instructions;
- The final stage of processing is feedback of the *Assessment Record* to the *Activity Selection* that may in turn result in a modification of the ASIs presented to the *Candidate*.

2.2.2 Low-Stakes Assessment Use-Case

The Tutor use-case is similar to the Assessment use-case. The differences are that the Candidate will receive a range of feedback information including hints and one or more possible solutions. The Assessment Engine's tutor processing sequence is:

- The *Tutor* constructs/selects the ASIs to be used throughout the tutoring procedure. These ASIs will be stored in some internal database and as such the dynamic sequencing information must be self contained. Candidates may be able to act as their own tutor with some control over their activity selection;
- The tutor session is activated by the *Candidate.* The *Candidate* responds to the ASIs and produces a set of *Responses*, again stored internally. The *Responses* are the set of item identifiers including response-type identifiers plus associated information that accurately characterize the response;
- Each *Response* is evaluated by the *Response Processing* to construct the *Item* store. This scoring requires the usage of a set of *Evidence Rules* that are used to define the key parameters through which the responses are to be evaluated. The resulting Item evaluation is stored in the *Outcomes* data structure. This information is then used to generate Feedback e.g. *Hints* or to reveal a partial or complete *Solution*.

The rest of the processing is as per the Assessment use-case.

2.3 Interactive Content-Based Use-Case

It is possible to use the QTI-XML to realize any form of content learning material. The content need not be used for any form of evaluation. The process for developing this content is:

- An authoring tool is used to construct the appropriate content and layout. Wizard-based authoring should be used whenever a question-based form of content is required e.g. a multiple-choice question. The author should ensure that the full Item is created i.e. including presentation material, response processing, feedback and the meta-data description. This material is then exported to its equivalent QTI-XML instance;
- For interactive content exchange between an LMS and the content rendering engine the corresponding interaction model has to be defined. The different components of the QTI-XML are now mapped onto this transaction model e.g. the LMS may use the QTI-XML to launch the presentation material only with the user response being sent back to the LMS within which the QTI-XML response processing is used. This could then result in the appropriate feedback being sent from the LMS to the content rendering system again using the QTI-XML representation.

3. Questions, Items, and Responses

The terminology adopted for the QTI is that an *Item* is defined as the fundamental block that contains one or more questions and responses. As such the concept of an *Item-type*, or for that matter question-type, is inappropriate and so the fundamental reference identity will be based upon *Response-type*. The *Response-type* is the unique identifier for the type of response required from the user e.g. a selection for a multiple-choice question or a string for a fill-in-blank question.

3.1 A Response-Type Taxonomy

The adopted response-type taxonomy is shown in Figure 3.1. An IMS Response-type can be *Basic* or *Composite* (the third category is the Proprietary group):

- Basic – one that contains only a single type of response;
- Composite – a composite response-type refers to a response that acts as a *container* for (sub-) response, normally different combinations of the basic response-types. The series of the sub-response-types are usually related to each other thereby constructing a thematic item.

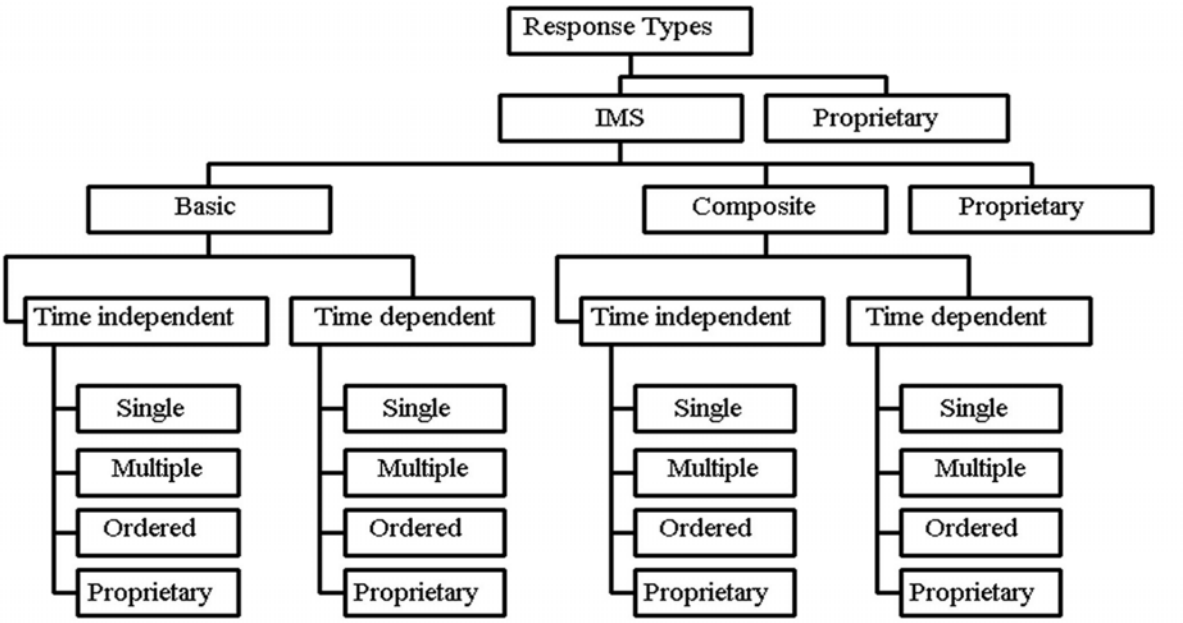

Figure 3.1 A response-type taxonomy.

The taxonomies below the Basic and Composite categories are identical. The next sub-division is based upon:

- Time Dependent – the time taken to respond is important and must be recorded. This could be used by response-types which set a sequence of events to be completed in a predefined period or where the sequence of response-types is determined by the time taken to complete certain responses;
- Time Independent – the time taken to respond is not significant;
- The final level of categorization in Figure 3.1 is based upon the number of actions required from the user. This categorization gives rise to Table 3.1.

Table 3.1 User action classification.

Response-type	Basic	Composite
Single	A single user response with each item consisting of a single response-type.	A single user response with each item consisting of more than one response-type. Some of the responses will therefore be 'null'.
Multiple	One or more user responses with each item consisting of a single response-type.	One or more user responses with each item consisting of more than one response-type. Some of the responses may be 'null'.
Ordered	One or more user responses with each item consisting of a single response-type, and the order of selection being significant.	One or more user responses with each item consisting of more than one response-type, and the order of the selection being significant. Some of the responses may be 'null'.

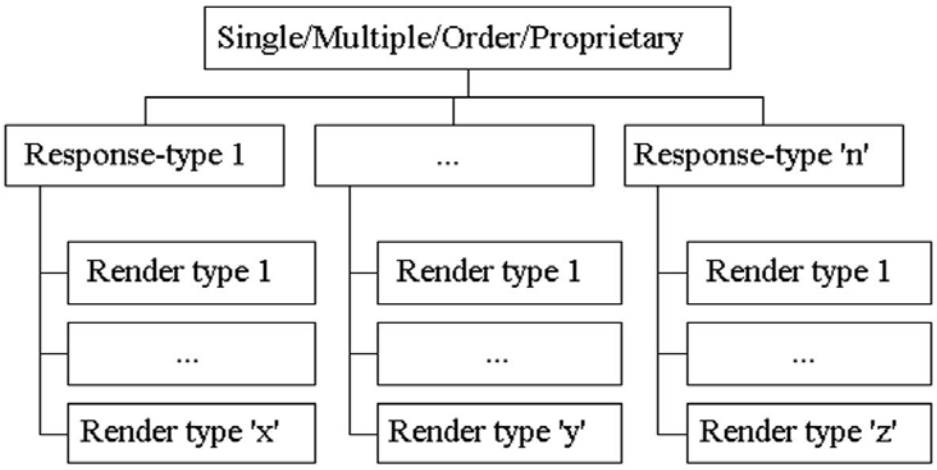

Figure 3.2 The relationship between response-type and rendering.

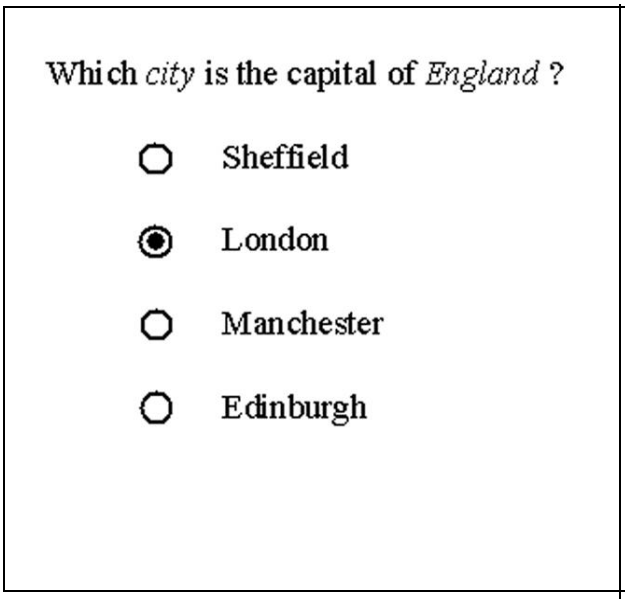

Figure 3.3a Standard text-based rendering of a multiple choice question.

Figure 3.3b Hot-spot rendering of a multiple choice question.

The next level of taxonomy of the Response-type is shown in Figure 3.2. In Figure 3.2 the relationship between the response type and the different presentation formatting, or rendering, is shown. For each of the classifications there are a number of Response-types and for each Response-type there are one or more ways of rendering that response selection. An example of this multiple rendering is shown in Figures 3.3a and 3.3b. In these two examples the same question is asked ('Which city is the capital of England?') but it is presented/rendered in two different formats[1]:

- Figure 3.3a – using a standard list of text responses with radio buttons;
- Figure 3.3b – using a graphic with marked hot-spots.

The feature of these two renderings is that the same generic action is required of the user – the identification of one correct piece of information from several possible options. The classification scheme is independent of the possible rendering formats because this is a reflection of the rendering engine and the educational objectives. The reason for adopting this form of categorization is that it is independent of the actual response-types and focuses on the actions required of the user. This means that:

- New response-types can be readily added without altering the classification scheme;
- Rendering is independent of the classification schemes;
- User actions are accurately represented thereby reflecting the required data flow.

3.2 Response-Types

The primary objectives of defining the response-types are to establish a common vocabulary and naming conventions and to establish the underlying data structure requirements.

3.2.1 Basic Response-Types

The basic response-types explicitly supported by this specification are listed in Table 3.2. Table 3.2 shows the relationship between the Response-types, the more colloquially identified question types and the Single/Multiple/Ordered classification schemes adopted by this specification. This representation uses the colloquial-types as the rendering forms for the Response-types.

1. The two examples in Figure 3.3 are based upon different educational objectives but this not a consideration of the specification. The example clearly demonstrates that a multiple-choice question can be rendered in more than one way.

The five Response-types become the core information model response-type objects. The three single/multiple/ordered categories become attributes of the basic response-type class, the five instances of which become the response-types. A range of rendering types can then be applied to these response types i.e. the rendering type is the presentation format of the response-type to the user.

The colloquial question types supported by this specification are[2]:

- True/false – multiple choice question with either a 'true or false', 'agree or disagree', etc. response identified by the response identity;
- Multiple choice – multiple choice question with one of the available choices identified by the response identity;
- Multiple response – multiple choice question with one or more of the choices identified by the response identities;
- Image hot spot (IHS) – the response-type is the location on a graphic identified by the 'x-y' co-ordinates of the point of selection;
- Fill-in-blank (FIB) – formatted entry place for text or integer/decimal/scientific number identified by the entered information. The response-type is either a string or integer/decimal/scientific number respectively for each response identity;
- Select text – identification of text from a presented paragraph or list. The response is the identified string or a mapping to a logical identifier;
- Slider – selection of an integer or real number from a predefined minimum and maximum with a set increment. The response-type is a real or integer number, or a mapping to a logical identifier;
- Drag object – these objects are moved into predefined object locations. The response type is identified by the pairing of the source object with the target object identities;

Table 3.2 Basic response-types[3].

Response-type	Data Structure	Rendering Formats		
		Single	**Multiple**	**Ordered**
Logical Identifier (LID)	The response-type identity or list of identities. The order of the list is first choice, second choice, etc.	Multiple choice True/false Slider	Multiple response	Order objects Connect-the-points Match object Order object Drag object Drag target
X-Y Co-ordinates (XY)	The 'x-y' co-ordinates of the centre of the object for each response identity or a list of 'x-y' co-ords. The order of the list is first choice, second choice, etc.	Image hot spot	Order objects	Connect-the-points
String (STR)	The typed string for each response identity.	Fill-in-blank Select text Short answer Essay		
Numerical (NUM)	The entered number for each response identity.	Fill-in-blank Slider		

2. Examples of all of these colloquial question types and their usage in rendering the response-types is given in the IMS QTI: ASI Best Practice & Implementation Guide [QTI, 02b].

3. Examples of all of these Response-types is given in the IMS Q&TI: ASI Best Practice & Implementation Guide [QTI, 02b].

Logical Groups (GRP)	The response identity and group identity tuples for each matched set of objects.	Match objects Drag object Drag target	Match objects Drag objects Drag targets	Match objects Order objects

- Drag target – objects are dropped into the target object. The response-type is identified by the pairing of the target object with the moved object identities;
- Ordered Objects – the re-ordering of scrambled text or text lines or a set of objects have to be moved to pre-defined locations on a page. The response is identified by either the set of 'x-y' co-ordinates of the response identities or their logical group;
- Match Objects – object from each list has to be grouped together. The response-type is an n-tuple of the set of matched items such that for each object its response identity and group number are recorded;
- Connect the points – the ordered connection of a set of points. The response-type is a set of 'x-y' co-ordinates or LIDs.

All of these colloquial question types can be supported by the five response-types listed in Table 3.2. In many cases the response-types can be rendered using different colloquial question types and so the rendering engine must be supplied with sufficient information to map back to the response-type. It is the response type that is used to drive the scoring and feedback mechanism.

3.2.2 Composite Response-Types

Composite Response-types are responses in which the user will have to answer two or more basic response-types (these basic types may be the same)[4]. Examples of two composite Response-types are shown in Figure 3.4 (based upon several response-types of the same type) and 3.5 (based upon two different response-types – multiple choice and FIB).

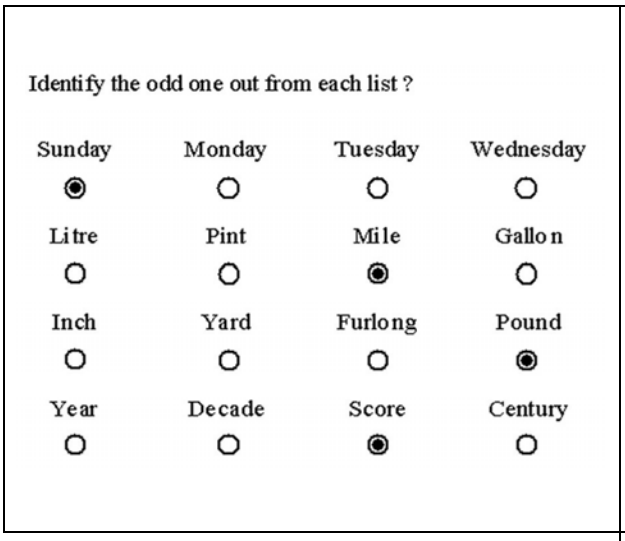

Figure 3.4 Composite response-type based upon the same basic response-types.

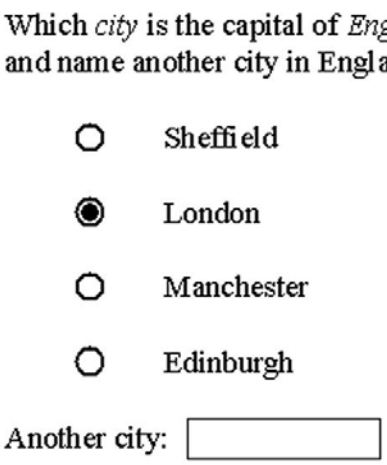

Figure 3.5 Composite response-type based upon the different basic response-types.

The range of possible composite types is considerable and as such no attempt is made to identify all of them.

3.2.3 Proprietary Extensions

A key requirement for the specification is its support for proprietary response-types and rendering formats. The points at which the proprietary extensions fit within the response-type taxonomy are clearly denoted in Figure 3.1:

4. The difference between a basic response-type that requires multiple responses e.g. multiple response, or a composite response-type based upon several of the same response-types is an artifact of the adopted definitions. If the response-type does NOT exist as a basic type then multiple entries are only possible through the construction of a composite response-type. At some later point IMS may decide to adopt this as a basic multiple response-type.

- As an alternative to the set of IMS types;
- As an alternative to the *Basic* and *Composite* classifications;
- As an alternative to the Single/Multiple/Ordered classifications.

Further extensions are possible in the range of rendering types as shown in Figure 3.2. The final issue is whether or not the range of basic response-types, listed in Table 3.2, need to be extended. The XML binding will describe a mechanism by which proprietary extensions are available should new response-types be required by vendors.

The process by which proprietary extensions can be supported is further defined in the IMS Q&TI XML Best Practice & Implementation Guide [QTI, 02b].

4. Basic Information Model

4.1 Assessment, Sections, Items, and Object-Banks

The IMS QTI specification is based upon four core data objects, namely:

- Item – the smallest exchangeable object within QTI-XML. An Item is more than a 'Question' in that it contains the 'Question', the presentation/rendering instructions, the response processing to be applied to the participant's response(s), the feedback that may be presented (including hints and solutions) and the meta-data describing the Item;
- Assessment – an Assessment is equivalent to a 'Test'. It contains the collection of Items that are used to determine the level of mastery, or otherwise, that a participant has on a particular subject. The Assessment contains all of the necessary instructions to enable variable sequencing of the Items and the corresponding aggregated scoring for all of the Items to produce the final score;
- Section – a Section is used to construct hierarchical evaluation objects. A Section may contain one or more other Sections. A Section is used to support two different needs:-
  - To represent different grouping constructs as defined by the appropriate educational paradigm e.g. a Section could be equivalent to a subject topic
  - To constrain the extent of the sequencing instructions and to control the ways in which the different possible sequences may be constructed;
- Object-bank – this is a collection of Items, Sections or a mixture of Items and Sections. An object-bank has its own unique identifier and meta-data to enable its contents to be searched. An object-bank is used to contain the database of evaluation objects that can be used to construct Assessments.

4.2 Interoperable Data Structures

The underlying logical data structures for the QTI are shown in Figure 4.1. This representation shows the relationship between the ASI elements. This relationship is summarized as:

- An *Assessment* consists of at least one *Section* (c);
- A *Section* may contain other *Sections* (b) and (f);
- A *Section* may contain one or more *Items* (d) and (h) – this permits the null Section definition;
- An *Object-bank* may consist of only Items, only Sections, or a mixture of Items and Sections.

While the basic data structure definition at the root level is simple it is extremely flexible. As such the data structure can be used to import/export data structures that consist of:

- One assessments only (c) and (g);
- One or more sections only (b) and (f);
- One or more items only (a) and (e);
- An assessment may or may not contain more than one section (c) and (g);
- A section may or may not contain items (b), (c), (f) and (g);
- One object-bank (d) and (h).

Object banks are exchanged using by defining a type of QTI package i.e. a set of similar data objects contained within the <questestinterop> element.

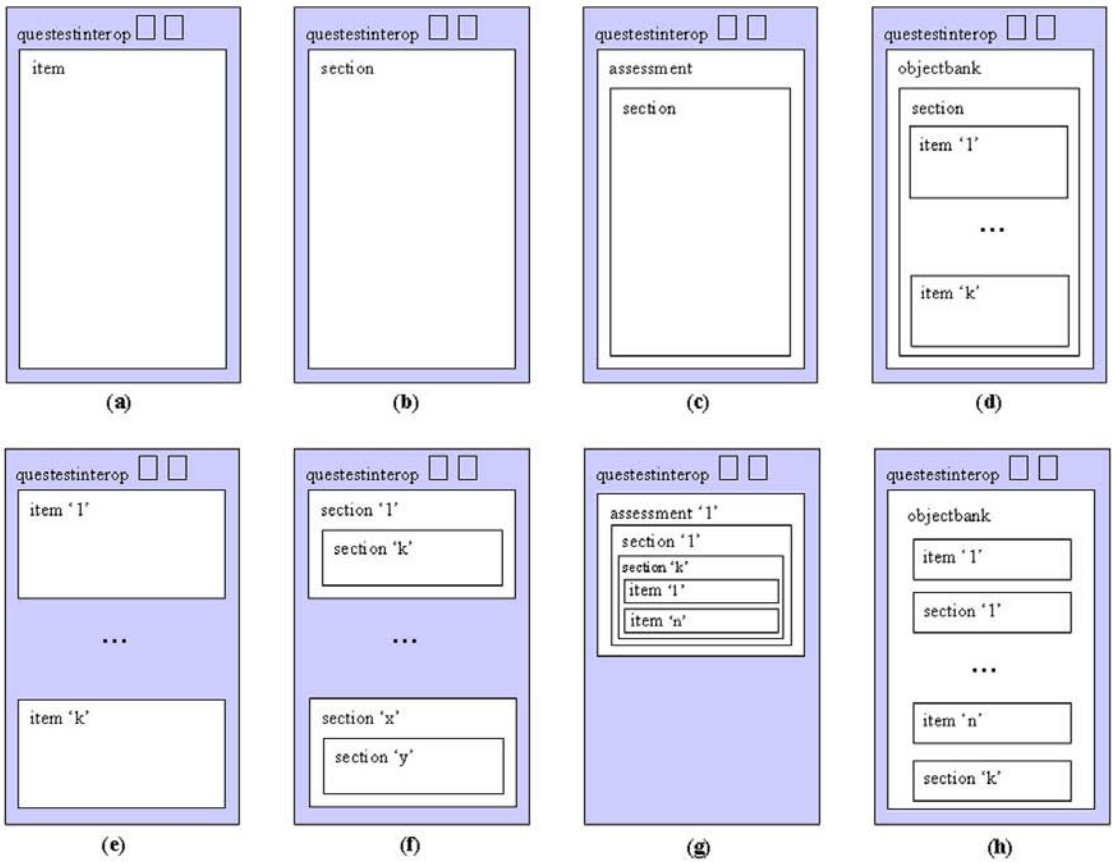

Figure 4.1 The principle IMS QTI data structures.

4.3 Underlying Object Model

The conceptual object model for the Q&TI is shown in Figure 4.2. The objects in this model and their key behaviors are:

- Assessment – the object that represents the *Assessment* data structure;
- Section – the object that represents the *Section* data structure;
- Item – the object that represents the *Item* data structure;
- Activity Selection – selection of the next activity determined by the progress and results obtained up to the moment of activity selection;
- Outcomes Processing – the reconciliation of all the evaluation outputs to produce an overall Assessment/Section evaluation;
- Scoring Weights – the scoring weights that are to be assigned to the results output from the response processing;
- Response Processing – the processing and evaluation of the user responses;
- Presentation – the rendering of the content and the possible responses;
- Examinee Record – the set of collated results that are output from the complete process. This could be a 'life-long' record in that it contains the historical progress of the individual;
- Outcomes – the set of outcomes that are to be evaluated by the response processing object. These determine the scoring metrics to be applied to the response evaluations;

- Response – the responses that are supplied by the user of the Items i.e. the input user selections;
- Flow – the underlying presentation structure that defines the block relationship between the different material components;
- Material – the content that is to be displayed.

The current scope of Version 1.2 is defined by the Assessment, Section, Item, Presentation, Response Processing, Outcomes, Response, Flow and Material objects shown in Figure 4.2

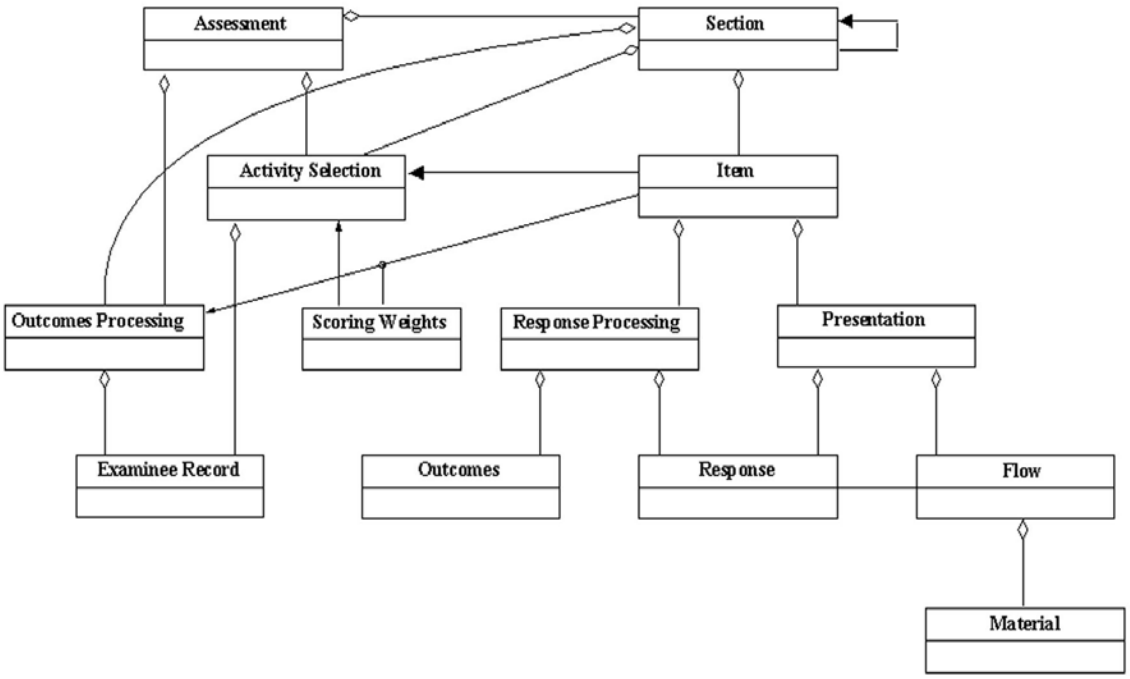

Figure 4.2 The underlying object-based information model.

4.4 Response-Types

Within an Item there is a complex set of data structures based upon the Response-type. The information returned by the basic Response-types can be defined in terms of lists of objects, namely[5]:

- Logical identifier (LID)

Single	=	{identifier}, {duration}
Multiple	=	{identifier, identifier, …, identifier, duration}, {duration}
Ordered	=	{event_1_identifier, event_2_identifer,…, event_k_identifier}, {duration}

- X-Y co-ordinates (XY)

Single	=	{{identifier, xcoord, ycoord}}, {duration}
Multiple	=	{{identifier, xcoord, ycoord}, {identifier, xcoord, ycoord},…,{identifier, xcoord, ycoord}}, {duration}
Ordered	=	{{event_1_identifier, xcoord, ycoord}, {event_2_identifier, xcoord, ycoord},…,{event_k_identifier, xcoord, ycoord}},

5. The ‘kth’ identifier in the lists denotes the last case.

{duration}

- String (STR)

  Single = {{identifier, string}}, {duration}

  Multiple = {{identifier, string}, {identifier, string},…, {identifier, string}}, {duration}

  Ordered = {{event_1_identifier, string}, {event_2_identifier, string},…, {event_k_identifier, string}}, {duration}

- Numerical

  Single = {{identifier, number}}, {duration}

  Multiple = {{identifier, number}, {identifier, number},…, {identifier, number}}, {duration}

  Ordered = {{event_1_identifier, number}, {event_2_identifier, number},…, {event_k_identifier, number}}, {duration}

- Logical group (GRP)

  Single = {{{identifier, groupid}, {identifier, groupid}}}, {duration}

  Multiple = {{{identifier, groupid}, {identifier, groupid},…,{identifier, groupid}}, {{identifier, groupid}, {identifier, groupid},…,{identifier, groupid}},…,{{identifier, groupid}, {identifier, groupid}, …,{identifier, groupid}}}, {duration}

  Ordered = {{{event_1_identifier, groupid}, {event_1_identifier, groupid},…, {event_1_identifier, groupid}}, {{event_2_identifier, groupid}, {event_2_identifier, groupid},…,{event_2_identifier, groupid}},…, {{event_k_identifier, groupid}, {event_k_identifier, groupid},…, {event_k_identifier, groupid}}}, {duration}

In each case the Response-type clause identifier is used to tag the data-set thereby ensuring that the scoring attributes can be correlated to the generating response.

The {duration} element is the period between the item being triggered and the response(s) being supplied. The period is defined as complete when the next Item is invoked or when some other pre-defined termination sequence is entered by the user (the generation of this value is a vendor specific feature).

4.5 Content

4.5.1 Flows

During adoption of the IMS QTI v1.0 specification it was noted that there was an issue arising from the display of multiple <material> blocks. This issue is demonstrated in Figure 4.3 (this example is taken from the IMS QTI Best Practice & Implementation Guide [QTI, 02b]). In this example there are three FIB questions posed in a single Item. This continuous text and the introductory question text are contained in several <material> elements. The problem is that there is no clear blocking semantics defined for the <material> element and so it is unclear how the first sentence should be defined as a separate paragraph. To rectify this issue the concept of ‘flows’ has been introduced.

Fill-in-the blanks in this text from Richard III:

Now is the _ _ _ _ _ _ of our discontent made glorious _ _ _ _ _ _ by these sons of _ _ _ _ .

Figure 4.3 Unclear semantics for text paragraphs.

A flow is defined as a set of content that is to be handled by the display rendering engine as a logical block, or paragraph. How the block is delimited is undefined and left to the display engine – the only constraint is that the display engine handles blocks consistently, including blocks within blocks, etc[6]. A flow can contain other flows and so a complex system of hierarchical flows can be constructed – again it is left to the display engine to decide how these should be consistently displayed. In the case of Figure 4.3, we have two flows or blocks.

In V1.1/1.2 flows may or may not be used – this ensures backwards compatibility. When flows are used this will be indicated by the presence of the top-level <flow> element within the <presentation> element. If any flow construct is to be used then the <flow> element must be present within the <presentation> element. Three separate elements have been defined to support flows:

- <flow> – this is used to indicate the top level flow within the <presentation> element;
- <flow_label> – this is used to encapsulate the <response_label> element;
- <flow_mat> – this is used to encapsulate the <material> element e.g. for <objectives>, <rubric>, etc.

In all three cases the element can be recursive i.e. <flow_mat> within <flow_mat>, and the blocking rules must be defined and implemented consistently (the rules can vary for each element but must be consistently applied). The availability of flows from V1.1/1.2 gives rise to the display guidelines shown in Figure 4.4:

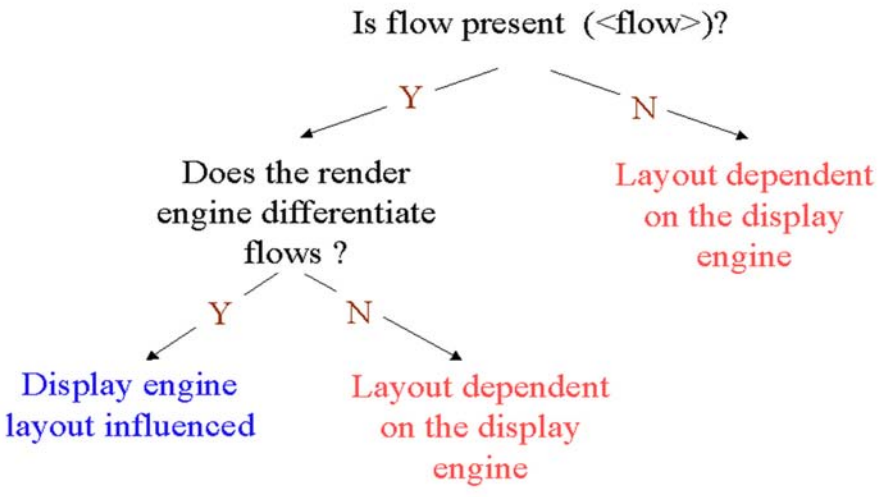

Figure 4.4 V1.0/V1.x flow implications.

6. It is strongly advised that the display engine should delimit a block using a new line and carriage return at the very least. It is also strongly recommended that a block within a block should be indented.

As implied in Figure 4.4, the usage of flows does not guarantee that the blocking will be implemented or that blocking in two different display engines will result in the same layout. Further control on the type of blocking is supported using the 'class' attribute on the three elements but the number of defined block structures is limited. The usage of flows allows authors to influence layout issues such as:

- Paragraphing for text;
- The interleaving of text with response-type prompts e.g. multiple FIB responses required for a single Item;
- The alignment of lists, including vertical or horizontal alignment of the options available within standard multiple-choice questions.

It is strongly advised that all V1.1 and later Items use the 'flow' approach. This enables a more clear set of semantics to be defined for controlling the layout of the Items and more readily supports techniques such as XML Style-sheets. Further refinement of the semantics for flows may be introduced in later versions of this specification once we have established best practice and identified further needs.

At first consideration, the concept of flows could be developed to included a broader range of stylistic capabilities such as font-type, color, lines-per-inch, etc. We have intentionally stopped short of being this prescriptive or feature-rich thereby ensuring that the specification does not become weighed-down with issues of style as opposed to our main goal of **functional interoperability**. Our intention is to allow the author to influence the layout without creating complications for display engines e.g. different fonts will lead to significant complications that are avoided by allowing the display-engine to use its own set of defaults

4.5.2 Text

A significant amount of content displayed to the participant will be of a textual nature. The QTI specification has extensive features for handling text-based content, namely:

- Mime type – the mime type associated with the text as defined using RFC1521. The default value is set as 'text/plain';
- Character set – the default value is set as 'us-ascii' but the range of possible values is as defined according to ISO10646. This character set is used to inform the system of the nature of the text contained or within the referenced file. XML supports two encoding formats namely: UTF-8 (default) and UTF-16. The encoding for the full XML instance is established in the opening line and so this must be sufficiently rich to support the entire file;
- Language – this is supported using the 'xml:lang' attribute. This allows the text to be made available in a variety of different languages. This mechanism is to be used to provide alternative language content in a single Item e.g. the material for the question supplied in French, German, English, etc. in the same Item. This should be achieved using a different <altmaterial> for each different language in the Item;
- White-space handling – this is supported using the 'xml:space' attribute. The default setting is that white-space is **not** preserved;
- Emphasis – under V1.1 the <matemtext> element was added. This is used to allow authors to distinguish certain parts of text from others. The manner in which the emphasis is achieved e.g. bold, italic, etc. is left to the display engine;
- Paragraphs – under V1.1 the flow structure was added (see sub-section 4.3.1). Also added was the <matbreak> element that is used to denote a break in the material e.g. a paragraph break perhaps. The nature of the break is undefined and left to the display engine but it is strongly advised that a line feed and carriage return form is used. The <matbreak> mechanism should only be used when the flows approach is unavailable;
- The position of a text-block can be controlled using the x0,y0 attributes to locate the top left hand corner of the block i.e. the anchor point for the text block. The relative height and width of the text block is defined using the 'Height' and 'Width' attributes. Whenever possible, the aspect ratio for the text block should be maintained.

It is important to stress that many stylistic issues pertaining to fonts are outside the scope of the specification. These issues should be handed using XSL style-sheets, externally referenced files such as HTML, etc.

4.5.3 Images

The presentation of images to the user requires the definition of the anchor point. The anchor point is defined by the pixel[a] co-ordinate of the top left-hand corner, in terms x0, y0. The other two attributes are the 'pixel-height' and 'pixel-width' of the image. Definition of both the height and width should cause the image to be presented in that aspect ratio. Omission of either the height or width will be taken to imply that the missing size must be determined automatically by maintaining the original aspect ratio of the image and using the supplied value as the reference length from which the missing length will be determined.

a. A pixel is as defined by the W3C – http://www.w3.org/TR/1999/REC-CSS1-19990111.

An example of a multi-image screen (800x600 pixels) is shown in Figure 4.5. The two images have their size and location defined by x0, y0 and width and height. The x0 and y0 points are defined with respect to the top left hand corner of the screen. The two hotspot images are also defined in a similar manner. In the case of overlapping images the order of precedence is defined by the order of the *response_label* elements - the first declared has the highest precedence.

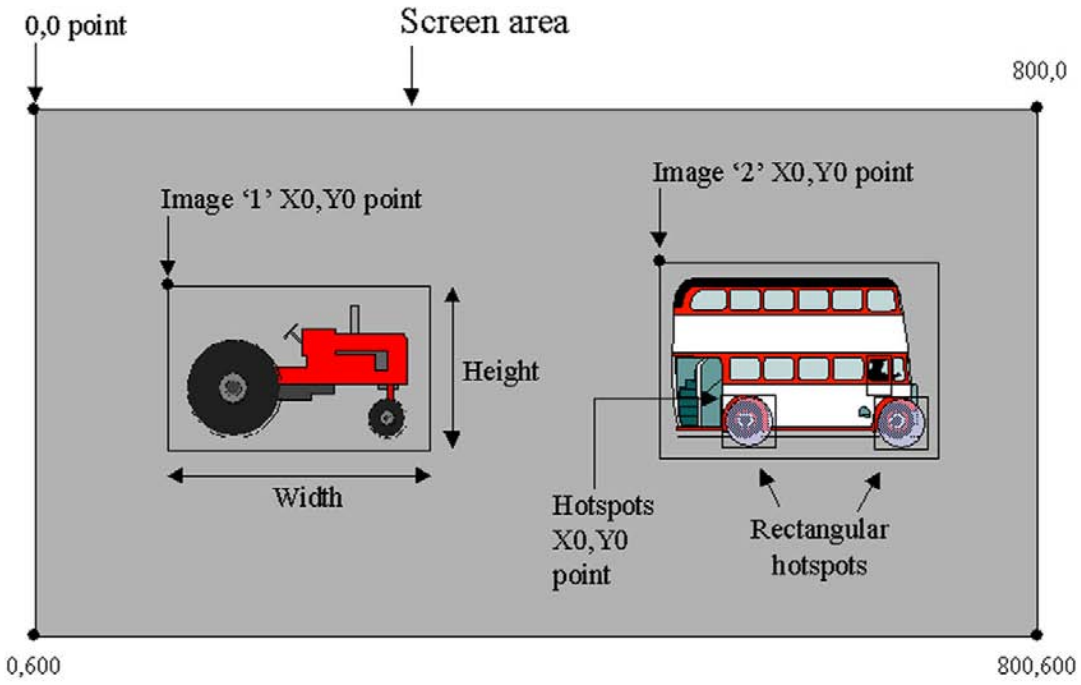

Figure 4.5 Multi-image screen layout reference.

4.5.4 Audio

For further study in V2.0.

4.5.5 Video

For further study in V2.0.

4.5.6 Application

The transfer of parameters to the application being launched should be achieved by encapsulating them in a CDATA block within the <matapplet> element.

For further study in V2.0.

4.5.7 Applet

The transfer of parameters to the Java applet being launched should be achieved by encapsulating them in a CDATA block within the <matapplet> element.

For further study in V2.0.

4.5.8 Referenced Content

In V1.2 the ability to store material that is to be referenced from various locations within an Assessment, and/or Section and/or Item was introduced. This content should be stored in the appropriate <reference> location (available to Assessments and Sections). Content stored in a <reference> object is available to all child objects i.e. if it is defined at the Section level then it is available to all contained Sections and/or Items.

Referencing the content contained within the <reference> structure is achieved using either the <matref> or the <material_ref> elements. The <matref> element is used to identify a particular content component e.g. <mattext>, <matimage>, etc whereas referencing of a full <material> structure is achieved using the <material_ref> element. The explicit limitation of <matref> to individual components of <material> was a clarification introduced in V1.2.

5. Conceptual Description of the Data Objects

The tables in this Section provide a conceptual, informative description of the elements in the data objects. The columns in these tables refer to:

No: The number of the data element. An element may be composed of sub-elements. The numbering scheme reflects these relationships.

Name: The descriptive name of the element.

Explanation: A brief functional description of the element.

Required: Indicates if the element is required:

- **M** = Mandatory Element that must be included in the data object, if the element at the higher level is included;
- **C** = Conditional Element. Existence is dependent on values of other Elements;
- **O** = Optional Element.

Multi: Multiplicity of the element:

- Blank = single instance;
- Number = maximum number of times the element is repeatable;
- **n** = multiple occurrences allowed, no limit;
- Repeatability of an element implies that all sub-elements repeat with the same element.

Type: A description of formatting rules for the data element, the set of valid entries for the data and the coding schemes. The set of values as defined in the Domain i.e. making it closed. The list of values cannot be extended to include values not defined in the specification. If there is a need for values not included in the domain set of values then the extension should be done defining a new element under the Extension element that is a part of each data object definition. Type includes the maximum length of the element's content:

- ID = element used to uniquely identify an object;
- Code = element value from a list of codes;
- Description = descriptive element, human language
- Flag = binary flag
- Enumerated = list of predefined non-numeric options
- The international character set specified by ISO 10646 will be used for all fields.

Note: Additional descriptive information about the element.

The description of the data objects has seven sub-sections:

- Questestinterop – the QTI root structure and contains the set of assessments, sections, items or object bank;
- Assessment – describes the assessment data structure;
- Section – describes the section data structure;
- Item – describes the item data structure;
- Common elements – describes the elements used in more than one of the above data structures;
- Common attributes – describes the attributes used in more than one of the above data structures;
- Meta-data – describes the QTI specific meta-data objects used in the Assessment, Section and Item data objects.

Note on Extensibility

This specification includes several points where proprietary extensions can be defined for each data object. Extensions are to be implemented in structures that are sub-elements. This applies to all extensions, including extensions to valid codes for elements that have a domain set of valid values as defined as part of the specification. Examples of valid extensions are provided in the IMS Question & Test Interoperability Best Practices & Implementation Guide [QTI, 01b].

5.1 <questestinterop> Data Object

The *Questestinterop* object is the root structure for the QTI specification. It can contain one or more Assessments, Sections or Items.

Table 5.1 <questestinterop> data object detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
1	questestinterop	The QTI root structure.				Must occur only once in a QTIASI-XML instance.
1.1	qticomment	Comments on the overall structure.	O		As per structure 5.6	
1.2	objectbank	The object-bank being exchanged.	O			Only one object-bank can be exchanged.
1.2.1	ident	As per structure 7.3				
1.2.2	qticomment	Comments on the overall structure of the objectbank.	O		As per structure 5.6	
1.2.3	qtimetadata	The QTI-specific meta-data used to describe the object-bank.	O	n	As per structure 5.13	
1.2.4	section	The section data object(s) composing the object-bank.	O	n	As per structure 3.1	
1.2.5	item	The item data object(s) composing the object-bank.	O	n	As per structure 4.1	
1.3	assessment	The assessment data object(s).	O		As per structure 2.1	
1.4	section	The section data object(s).	O	n	As per structure 3.1	
1.5	item	The item data object(s).	O	n	As per structure 4.1	

5.2 <assessment> Data Object

An *Assessment* object contains all of the information to make the use of individual *Items* meaningful i.e. apart from the *Sections* the object includes the relationships between the *Sections*, the group evaluation processing and the corresponding feedback.

Table 5.2 <assessment> data object detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
2.1	title	As per structure 7.2				
2.2	ident	As per structure 7.3				
2.3	xml:lang	As per structure 7.27				
2.4	qticomment	Comments on the Assessment.	O		As per structure 5.6	
2.5	duration	The duration of the Assessment.	O		As per structure 5.7	

2.6	qtimetadata	The QTI-specific meta-data assigned to the Assessment.	O	n	As per structure 5.13.	
2.7	objectives	The Assessment objectives per view of the system.	O	n	As per structure 5.11	
2.8	assessmentcontrol	Control of the capabilities to be permitted to operate within the Assessment.	O	n	There is no content for this element.	These switches should be used to control the operation of the Assessment related conditions. Each view can have its own switch definition.
2.8.1	view	As per structure 7.1				
2.8.2	solutionswitch	As per structure 7.4				
2.8.3	hintswitch	As per structure 7.5				
2.8.4	feedbackswitch	As per structure 7.6				
2.8.5	qticomment	Comments on the Assessment control.	O		As per structure 5.6	
2.9	rubric	Material used to describe the context of the Assessment to users.	O	n	As per structure 5.12	
2.10	presentation_material	Contains the material that is to be presented to set the context for the Assessment.	O		As per structure 5.15.	
2.11	outcomes_processing	Assessment accumulated processing and feedback.	O	n	The detailed definition and description of the outcomes processing is supplied in the IMS QTI ASI Outcomes Processing Specification [QTI, 02d].	
2.12	assessproc_extension	Proprietary alternative Assessment processing extension.	O		ANY	All proprietary alternatives to Assessment processing are to be implemented as sub-elements under this element (see the IMS QTI Best Practice Guide for the naming convention).
2.13	assessfeedback	Feedback of the Assessment scoring.	O	n		A response will be defined for each view.
2.13.1	title	As per structure 7.2				
2.32.2	ident	As per structure 7.3				
2.13.3	view	As per structure 7.1				
2.32.4	qticomment	Comments on the Assessment feedback to be used.	O		As per structure 5.6	
2.13.5	material	The content to be presented due to the score value.	C	n	As per structure 5.1	
2.13.6	flow_mat	Flow structuring of the material encapsulated.		n	As per structure 5.14	
2.14	selection_ordering	Defines the selection and ordering algorithms to be applied to the contained Sections.	O		The detailed definition and description of the outcomes processing is supplied in the IMS QTI ASI Selection & Ordering Specification [QTI, 02c].	

2.15	reference	The container for material that is to be referenced by the Sections and/or Items contained within the Assessment.	O		As per structure 5.16.	
2.16	sectionref	To pull into scope Sections that are not defined within this Assessment block.	C	n		The referenced Section must be available somewhere otherwise execution errors will occur. Binding is outside the scope of this specification.
2.16.1	linkrefid	As per structure 6.14				
2.17	section	The Section data object (see Section 5.3).	C	n		There will be at least one Section per Assessment and Sections can contain Sections.

5.3 <section> Data Object

A *Section* object contains all of the information to meaningfully group together *Items* i.e. apart from the *Items* the object includes the relationships between the *Items* and the selection criteria of the Items.

Table 5.3 <section> data object detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
3.1	title	As per structure 7.2				
3.2	ident	As per structure 3.3				
3.3	xml:lang	As per structure 7.27				
3.4	qticomment	Comments on the Section.	O		As per structure 5.6	
3.5	duration	The duration of the Section.	O		As per structure 5.7	
3.6	qtimetadata	The QTI-specific meta-data assigned to the Section.	O	n	As per structure 5.13.	
3.7	objectives	The Section objectives per view of the system.	O	n	As per structure 5.11	
3.8	sectioncontrol	Control of the capabilities to be permitted to operate within the Section.	O	n		These switches should be used to control the operation of the Section related conditions. A definition can be made for each view.
3.8.1	view	As per structure 7.1				
3.8.2	solutionswitch	As per structure 7.4				
3.8.3	hintswitch	As per structure 7.5				
3.8.4	feedbackswitch	As per structure 7.6				
3.8.5	qticomment	Comments on the Section control.	O		As per structure 5.6	

3.9	sectionprecondition (For further study in V2.0).	The preconditions that control whether or not the Section is utilized.	O	n	TBD	TBD
3.10	sectionpostcondition (For further study in V2.0).	The postconditions that control whether or not the Section is utilized.	O	n	TBD	TBD
3.11	rubric	Material used to describe the context of the Section to users.	O	n	As per structure 5.12	
3.12	presentation_material	Contains the material that is to be presented to set the context for the Section.	O		As per structure 5.15.	
3.13	outcomes_processing	Section accumulated processing and feedback.	O	n	The detailed definition and description of the outcomes processing is supplied in the IMS QTI ASI Outcomes Processing Specification [QTI, 02d].	
3.14	sectionproc_extension	Proprietary alternative Section processing extension.	O		ANY	All proprietary alternatives to Section processing are to be implemented as sub-elements under this element (see the IMS QTI Best Practice Guide for the naming convention).
3.15	sectionfeedback	Feedback of the Section scoring.	M	n		A response will be defined for each view.
3.15.1	title	As per structure 7.2				
3.15.2	ident	As per structure 7.3				
3.15.3	view	As per structure 7.1				
3.15.4	qticomment	Comments on the Section feedback to be used.	O		As per structure 5.6	
3.15.5	material	The content to be presented due to the score value.	C	n	As per structure 5.1	
3.15.6	flow_mat	Flow structuring of the material encapsulated.		n	As per structure 5.14	
3.16	selection_ordering	Defines the selection and ordering algorithms to be applied to the contained Sections and/or Items.	O		The detailed definition and description of the outcomes processing is supplied in the IMS QTI ASI Selection & Ordering Specification [QTI, 02c].	
3.17	reference	The container for material that is to be referenced by the Sections and/or Items contained within the Section.	O		As per structure 5.16.	
3.18	sectionref	To pull into scope Sections that are not defined within this Section block.	C	n	As per structure 2.15	
3.18.1	linkrefid	As per structure 7.14				
3.19	section	Self reference for recursive Sections.	C	n		

3.20	itemref	To pull into scope the Items that are not defined within this Section block.	C	n		The referenced Item must be available somewhere otherwise execution errors will occur. Binding is outside the scope of this specification.
3.20.1	linkrefid	As per structure 7.14				
3.21	item	The Item data object (see Section 5.4)	C	n		There may be zero, one or more Items per Section.

5.4 ITEM Data Object

An *Item* object contains all of the information for the presentation of a question to the participant and its subsequent processing to the user response. The structure of the *Item* includes the actual question and its presentation format, the range of possible responses, the ways in which the responses are to be processed, the possible solutions and hints to the *Item* and feedback.

Table 5.4 Item data object detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
4.1	title	As per structure 7.2				
4.2	ident	As per structure 7.3				
4.3	label	As per structure 7.7				
4.4	xml:lang	As per structure 7.27				
4.5	maxattempts	The number of attempts permitted.	O		#PCDATA. String (1-2 chars).	
4.6	qticomment	Comments on the Item.	O	As per structure 5.6		
4.7	duration	The duration of the Item.	O	As per structure 5.7		
4.8	itemmetadata	The Item metadata as listed in Section 7.3.	O			Will include only those entries that are mandatory or which are optional but defined.
4.8.1	qtimetadata		O	n	As per structure 5.13.	
4.8.2	qmd_computerscored	Whether or not the Item can be scored by computer.	O		As per structure 6.1 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).	
4.8.3	qmd_feedbackpermitted	Whether or not feedback is available.	O		As per structure 6.2 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).	
4.8.4	qmd_hintspermitted	Whether or not hints are available.	O		As per structure 6.3 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).	
4.8.5	qmd_itemtype	The type of Item used.	O		As per structure 6.4 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).	

4.8.6	qmd_levelofdifficulty	The education level for which the Item is intended.	O		As per structure 6.5 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.7	qmd_maximumscore	The maximum score possible from that Item.	O		As per structure 6.6 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.8	qmd_renderingtype	The type of rendering used within the Item.	O	n	As per structure 6.7 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.9	qmd_responsetype	The class of response expected for the Item.	O	n	As per structure 6.8 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.10	qmd_scoringpermitted	Whether or not scoring is available.	O		As per structure 6.9 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.11	qmd_solutionspermitted	Whether or not solutions are available.	O		As per structure 6.10 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.12	qmd_status	The status of the Item.	O		As per structure 6.11 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.13	qmd_timedependence	Whether or not the responses are timed.	O		As per structure 6.12 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.14	qmd_timelimit	The number of minutes or an unlimited duration.	O		As per structure 6.13 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.15	qmd_toolvendor	The name of the vendor of the tool creating the Assessment.	O		As per structure 6.14 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.16	qmd_topic	A brief description of the topic covered by the Item.	O		As per structure 6.15 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.17	qmd_material	The type of material used within the Item.	O	n	As per structure 6.16 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.18	qmd_typeofsolution	The type of solution available in the Item.	O		As per structure 6.17 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.8.19	qmd_weighting	The weighting to be applied to the Item's score.	O		As per structure 6.18 Deprecated in favour of the <qtimetadata> structure (see structure 4.8.1).
4.9	objectives	The Item objectives per view of the system.	O	n	As per structure 5.11

4.10	itemprecondition (For further study in V2.0).	The preconditions that control whether or not the Item is utilized.	O	n	TBD	TBD
4.11	itempostcondition (For further study in V2.0).	The postconditions that control whether or not the Item is utilized.	O	n	TBD	TBD
4.12	itemcontrol	Control of the capabilities to be permitted to operate within the Item.	O	n		These switches should be used to control the operation of the Item related conditions. A definition can be made for each view.
4.12.1	view	As per structure 7.1				
4.12.2	solutionswitch	As per structure 7.4				
4.12.3	hintswitch	As per structure 7.5				
4.12.4	feedbackswitch	As per structure 7.6				
4.13	itemrubric	The view specific description of the Item.	C	n		This will normally contain instructions pertaining to the Item. This element is deprecated in preference to 'rubric'.
4.13.1	view	As per structure 7.1				
4.13.2	material	The content of the rubric.	M		As per structure 5.1	
4.14	rubric	Material used to describe the context of the Item to users.	C	n	As per structure 5.12.	
4.15	presentation	The container for the responses (basic or composite) plus the rendering.	O			Only one view of the presentation is available.
4.15.1	label	As per structure 7.7				
4.15.2	xml:lang	As per structure 7.27				
4.15.3	x0	As per structure 7.9				
4.15.4	y0	As per structure 7.10				
4.15.5	height	As per structure 7.11				
4.15.6	width	As per structure 7.12				
4.15.7	qticomment	Comments on the Presentation.	O		As per structure 5.6	
The structure that follows is as per the original V1.0 specification and is maintained for backwards compatibility. The alternative approach is to use the flow element as introduced in V1.1 – see structure 4.15.14						
4.15.8	material	The content of the responses.	C	n	As per structure 5.1	This will form part of the question itself.
4.15.9	response_lid	The logical identifier response-type.	C	n		As defined in the IMS QTI Information Model.
4.15.9.1	ident	As per structure 7.3				
4.15.9.2	rcardinality	As per structure 7.16				
4.15.9.3	rtiming	As per structure 7.17				

4.15.9.4	material	The content of the response types.	O		As per structure 5.1	This will form part of the question itself.
4.15.9.5	render_choice	Rendering of the classical multiple choice/multiple response and true/false questions.	O			
4.15.9.5.1	shuffle	Whether or not the possible selections should be shuffled for presentation.	O		Enumerated: Yes (default) No	Default value is "No".
4.15.9.5.2	minnumber	As per structure 7.21				
4.15.9.5.3	maxnumber	As per structure 7.22				
The structure that follows is as per the original V1.0 specification and is maintained for backwards compatibility. The alternative approach is to use the flow_label element as introduced in V1.1.						
4.15.9.5.4	material	The content of the responses.	C	n	As per structure 5.1	This will be a part of the question itself.
4.15.9.5.5	response_label	A possible response that can be selected.			May contain #PCDATA.	
4.15.9.5.5 .1	ident	As per structure 7.3				
4.15.9.5.5 .2	rshuffle	Determines if the response can be shuffled.	O		Enumerated: Yes No (default)	Default is "No".
4.15.9.5.5 .3	rarea	The type of area used to denote the hot spot.	O		Enumerated: Ellipse Rectangle Bounded	Information describing the key points must be given. The ellipse is 'x,y,r1,r2', the rectangle is 'x0,y0,height,width' and the bounded area is 'x1y1,…,xnyn'.
4.15.9.5.5 .4	rrange	The accuracy of the numerical result required.	O		Enumerated: Exact (default) Range	'Exact' means exactly whereas 'Range' is followed by the range permitted about the given value.
4.15.9.5.5 .5	labelrefid	This reference to an identifier is used to link this response label with a particular response processing mechanism.	O		CDATA	This identifier mechanism is deprecated.
4.15.9.5.5 .6	match_group	The set of response labels to which this object may be matched.	O		CDATA String 1-255 chars.	This is a comma separated list of the response label identifiers allocated to the other response labels to which this object can be matched.
4.15.9.5.5 .7	match_max	The maximum number of times that this labelled object can be matched with some other object.	O		CDATA String 1-2 chars.	
4.15.9.5.5 .8	qticomment	Comments on the labelled structure.	O		As per structure 5.6	

4.15.9.5.5.9	material	The content of the response label.	O	n	As per structure 5.1	
4.15.9.5.5.10	material_ref	Reference identifier to the content of the response label.			As per structure 5.16	
4.15.9.5.5.11	flow_mat	Flow structured content for the response label.			As per structure 5.13	
The next structures are the preferred flow_label elements as introduced V1.1.						
4.15.9.5.6	material_ref	Reference identifier to the content of the rendering.	C	n	As per structure 5.16	
4.15.9.5.7	flow_label	Establishes the flow block around the possible response-label structures.				
4.15.9.5.7.1	class	Guidance on the type of block structuring.	O		As per structure 7.25	
4.15.9.5.7.2	response_label	A possible response that can be selected.	C	n	As per structure 4.15.9.5.5	
4.15.9.5.7.3	flow_label	Recursive structure to support complex block layouts.			As per structure 4.15.9.5.7	
4.15.9.5.8	response_na	Proprietary extension for not attempted response.	O		ANY	All NA extensions are to be implemented as sub-elements under this element (see the IMS QTI Best Practice Guide for the naming convention).
4.15.9.6	render_hotspot	Rendering of the material using an image(s).	O			The images to which the responses are referenced.
4.15.9.6.1	minnumber	As per structure 7.21				
4.15.9.6.2	maxnumber	As per structure 7.22				
4.15.9.6.3	showdraw	Informs the rendering system that the points identified by the user are to be displayed 'as connected' using some marking mechanism.	O		Enumerated: Yes No (default)	
The structure that follows is as per the original V1.0 specification and is maintained for backwards compatibility. The alternative approach is to use the flow_label element as introduced in V1.1.						
4.15.9.6.4	material	The content of the responses.	C	n	As per structure 5.1	This will be a part of the question itself.
4.15.9.6.5	response_label	A possible response that can be selected.			May contain #PCDATA.	
The next structures are the preferred flow_label elements as introduced in V1.1.						
4.15.9.6.6	material_ref	Reference identifier to the content of the rendering.	C	n	As per structure 5.16	
4.15.9.6.7	flow_label	Establishes the flow block around the possible response-label structures.				
4.15.9.6.6	response_na	As per structure 4.15.9.5.8				
4.15.9.7	render_slider	Rendering of the response as a slider.	O			The form of the slider is host dependent.

4.15.9.7.1	orientation	The orientation of the slider.	O		Enumerated: Horizontal Vertical	The physical style of the slider is vendor dependent.
4.15.9.7.2	lowerbound	The lowest value shown by the slider.	M		String 16 chars.	This value must be less than 'upperbound'.
4.15.9.7.3	upperbound	The highest value shown by the slider.	M		String 16 chars.	This value must be greater that 'lowerbound'.
4.15.9.7.4	step	The increment value of the slider.	O		String 16 chars.	
4.15.9.7.5	startval	The setting at which the slider is set when displayed.	O		String 16 chars.	Must be in the range of LowerBound to UpperBound.
4.15.9.7.6	steplabel	Display of the units on the slider.	O		Enumerated: Yes (default) No	Default setting is "Yes".
4.15.9.7.7	minnumber	As per structure 7.21				
4.15.9.7.8	maxnumber	As per structure 7.22				
The structure that follows is as per the original V1.0 specification and is maintained for backwards compatibility. The alternative approach is to use the flow_label element as introduced in V1.1.						
4.15.9.7.9	material	The content of the responses.	C	n	As per structure 5.1	This will be a part of the question itself.
4.15.9.7.10	response_label	A possible response that can be selected.			May contain #PCDATA.	
The next structures are the preferred flow_label elements as introduced in V1.1.						
4.15.9.7.11	material_ref	Reference identifier to the content of the rendering.	C	n	As per structure 5.16	
4.15.9.7.12	flow_label	Establishes the flow block around the possible response-label structures.				
4.15.9.7.13	response_na	As per structure 4.15.9.5.8				
4.15.9.8	render_fib	Rendering of the material using a FIB format.	O			
4.15.9.8.1	charset	The character-set to be used for the entry.	O		As per MIME in RFC1521. CDATA string describing the character set.	Default setting is "us-ascii".
4.15.9.8.2	encoding	The coding to be used for the text.	O		String. CDATA string describing the encoding.	Default setting is "UTF-8". Typical entries are given in the Best Practice & Implementation Guide.
4.15.9.8.3	fibtype	The type of information expected.	O		Enumerated: String (default) Integer Decimal Scientific Boolean	Default setting is "String".
4.15.9.8.4	rows	The number of rows available for the entry.	O		String 3 chars.	

4.15.9.8.5	columns	The number of columns available for the entry.	O		String 3 chars.	
4.15.9.8.6	maxchars	The maximum number of characters that can be entered.	O		String 8 chars.	
4.15.9.8.7	prompt	The style of holder presented to contain the material.	O		Enumerated: Box (default) Dashline Asterisk Underline	Default setting is 'Box".
4.15.9.8.8	minnumber	As per structure 7.21				
4.15.9.8.9	maxnumber	As per structure 7.22				
The structure that follows is as per the original V1.0 specification and is maintained for backwards compatibility. The alternative approach is to use the flow_label element as introduced in V1.1.						
4.15.9.8.10	material	The content of the responses.	C	n	As per structure 5.1	This will be a part of the question itself.
4.15.9.8.11	response_label	A possible response that can be selected.			May contain #PCDATA.	
The next structures are the preferred flow_label elements as introduced in V1.1.						
4.15.9.8.12	material_ref	Reference identifier to the content of the rendering.	C	n	As per structure 5.16	
4.15.9.8.13	flow_label	Establishes the flow block around the possible response-label structures.				
4.15.9.9	render_extension	Proprietary extensions facility.	O		ANY	All extensions to the render-type are to be implemented as sub-elements under this element (see the IMS QTI best Practice Guide for the naming convention).
4.15.10	response_xy	The X-Y co-ordinate response-type.	C	n		As defined in the IMS QTI Information Model.
4.15.10.1	ident	As per structure 7.3				
4.15.10.2	rcardinality	As per structure 7.16				
4.15.10.3	rtiming	As per structure 7.17				
4.15.10.4	material	The content of the response types.	O		As per structure 5.1	This will form part of the question itself.
4.15.10.5	render_choice	As per 4.15.9.5				
4.15.10.6	render_hotspot	As per 4.15.9.6				
4.15.10.7	render_slider	As per 4.15.9.7				
4.15.10.8	render_fib	As per 4.15.9.8				
4.15.10.9	render_extension	As per 4.15.9.9				
4.15.11	response_str	The string response-type.	C	n		As defined in the IMS QTI Information Model.
4.15.11.1	ident	As per structure 7.3				
4.15.11.2	rcardinality	As per structure 7.16				

4.15.11.3	rtiming	As per structure 7.17				
4.15.11.4	material	The content of the response types.	O		As per structure 5.1	This will form part of the question itself.
4.15.11.5	render_choice	As per 4.15.9.5				
4.15.11.6	render_hotspot	As per 4.15.9.6				
4.15.11.7	render_slider	As per 4.15.9.7				
4.15.11.8	render_fib	As per 4.15.9.8				
4.15.11.9	render_extension	As per 4.15.9.9				
4.15.12	response_num	The numerical response-type.	C	n		As defined in the IMS QTI Information Model.
4.15.12.1	ident	As per structure 7.3				
4.15.12.2	rcardinality	As per structure 7.16				
4.15.12.3	rtiming	As per structure 7.17				
4.15.12.4	material	The content of the response types.	O		As per structure 5.1	This will form part of the question itself.
4.15.12.5	render_choice	As per 4.15.9.5				
4.15.12.6	render_hotspot	As per 4.15.9.6				
4.15.12.7	render_slider	As per 4.15.9.7				
4.15.12.8	render_fib	As per 4.15.9.8				
4.15.12.9	render_extension	As per 4.15.9.9				
4.15.13	response_grp	The logical group response-type.	C	n		As defined in the IMS QI Information Model.
4.15.13.1	ident	As per structure 7.3				
4.15.13.2	rcardinality	As per structure 7.16				
4.15.13.3	rtiming	As per structure 7.17				
4.15.13.4	material	The content of the response types.	O		As per structure 5.1	This will form part of the question itself.
4.15.13.5	render_choice	As per 4.15.9.5				
4.15.13.6	render_hotspot	As per 4.15.9.6				
4.15.13.7	render_slider	As per 4.15.9.7				
4.15.13.8	render_fib	As per 4.15.9.8				
4.15.13.9	render_extension	As per 4.15.9.9				
4.15.14	flow	The primary blocking structure that groups the presentation content.	O			The form of block structure is dependent upon the rendering engine. The semantics must be consistent with the ‘flow_label’ and ‘flow-mat’ elements.
4.15.14.1	class	The type blocking.	O		As per structure 7.25	
4.15.14.2	material	The content of the response types.	C	n	As per structure 5.1	This will form part of the question itself.

4.15.14.3	flow	Allows recursive flow structures to be used.			As per structure 4.15.14	
4.15.14.4	The alternative to the flow structure is the set of structures given in 4.15.8 to 4.15.13.				This ensures backwards compatibility with the V1.0 specifications. The usage of the 'flow' element is preferred for V1.1 onwards.	
4.16	resprocessing	The container for the processing of the responses.	O			This element defines the standard Item processing features. Proprietary alternatives are available.
4.16.1	scoremodel	As per structure 7.20. The usage of this attribute on the <resprocessing> element is deprecated.				
4.16.2	qticomment	Comments on the Response processing.	O		As per structure 5.6	
4.16.3	outcomes	The container for the declaration of the variables returned for response scoring.	M		As per structure 5.10	
4.16.4	respcondition	Evaluation of the response with respect to the defined conditions.	M	n		A series of conditions could be applied depending on the number and type of responses.
4.16.4.1	title	As per structure 7.2				
4.16.4.2	continue	As per structure 7.15				
4.16.4.3	qticomment	Comments on the Response Condition.	O		As per structure 5.6	
4.16.4.4	conditionvar	Conditions applied to the scores to determine the feedback.	M	n	As per structure 5.4.	
4.16.4.5	setvar	Manipulation of the declared scoring variables.	O	n	As per structure 5.3	
4.16.4.6	displayfeedback	Display trigger for the Item feedback.	O	n	As per structure 5.8.	
4.16.5	respcond_extension	Proprietary extension of the evaluation of the scores to determine the responses.	O		ANY	All extensions to the Item processing for new conditions are to be implemented as sub-elements under this element (see the IMS QTI Best Practice Guide for the naming convention).
4.17	itemproc_extension	Proprietary alternative Item processing extension.	O		ANY	All proprietary alternatives to Item processing are to be implemented as sub-elements under this element (see the IMS QTI Best Practice Guide for the naming convention).

4.18	itemfeedback	Feedback of the Item scoring and other types of feedback.	M	n		A response will be defined for each view and each type of feedback.
4.18.1	title	As per structure 7.2				
4.18.2	ident	As per structure 7.3				
4.18.3	view	As per structure 7.1				
4.18.4	material	The content to be presented due to the score value.	C	n	As per structure 5.1	
4.18.5	flow_mat	The block structured item feedback.		n	As per structure 5.13	
4.18.6	solution	The solutions available to the different views.		n		Different solutions can be available for tutors, etc.
4.18.6.1	feedbackstyle	As per structure 7.23				
4.18.6.2	view	As per structure 7.1				
4.18.6.3	qticomment	Comments on the available solutions.	O		As per structure 5.6	
4.18.6.4	solutionmaterial	Container for the set of contents to be revealed as the solution.	M	n		It is this level which acts as either the incremental or multiple content presented.
4.18.6.4.1	material	The content to be presented due as the solution.	C	n	As per structure 5.1	
4.18.6.4.2	flow_mat	The block structured solution feedback.		n	As per structure 5.13	
4.18.7	hint	The hints available to the different views.		n		Different hints can be available for tutors, etc.
4.18.7.1	feedbackstyle	As per structure 7.23				
4.18.7.2	view	As per structure 7.1				
4.18.7.3	qticomment	Comments on the available hints.	O		As per structure 5.6	
4.18.7.4	hintmaterial	Container for the set of contents to be revealed as the hint.	M	n		It is this level which acts as either the incremental or multilevel content presented.
4.18.7.4.1	material	The content of the actual hints.	C	n	As per structure 5.1	
4.18.7.4.2	flow_mat	The block structured hint feedback.		n	As per structure 5.13	

5.5 Common Data Objects (Elements)

Table 5.5 describes the data objects commonly used with the Objectbank, Assessment, Section and Item objects.

Table 5.5 Common object detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
5.1	material	The content container for all of the material to be displayed.	O			This will always require at least one sub-element.
5.1.1	label	As per structure 7.7				
5.1.2	xml:lang	As per structure 7.27				
5.1.3	qticomment	Comments on the Material.	O		As per structure 5.6	
5.1.4	mattext	Text to be presented.	O	n	PCDATA	
5.1.4.1	label	As per structure 7.7				
5.1.4.2	texttype	The type of text to be displayed.	O		CDATA in format 'text/****" String 32 As per MIME under RFC1521.	Default set as "text/plain". The Best Practice & Implementation Guide describes the typical range of values.
5.1.4.3	charset	The character set to be used.	O		CDATA String 32. As per ISO10646.	Default set as "us-ascii". The Best Practice & Implementation Guide describes the typical range of values.
5.1.4.4	uri	As per structure 7.8				
5.1.4.5	entityref	As per structure 7.26				
5.1.4.6	x0	As per structure 7.9				
5.1.4.7	y0	As per structure 7.10				
5.1.4.8	height	As per structure 7.11				
5.1.4.9	width	As per structure 7.12				
5.1.4.10	xml:lang	As per structure 7.27				
5.1.4.11	xml:space	As per structure 7.28				
5.1.5	matemtext	Emphasised text to be presented.	O	n	PCDATA	The style of the emphasis is render engine dependent but must be consistent for all occurrences of 'matemtext'.
5.1.5.1	label	As per structure 7.7				
5.1.5.2	texttype	The type of text to be displayed.	O		CDATA in format 'text/****" String 32 As per MIME under RFC1521.	Default set as "text/plain". The Best Practice & Implementation Guide describes the typical range of values.

5.1.5.3	charset	The character set to be used.	O		CDATA String 32 As per ISO10646.	Default set as “us-ascii”. The Best Practice & Implementation Guide describes the typical range of values.
5.1.5.4	uri	As per structure 7.8				
5.1.5.5	entityref	As per structure 7.26				
5.1.5.6	x0	As per structure 7.9				
5.1.5.7	y0	As per structure 7.10				
5.1.5.8	height	As per structure 7.11				
5.1.5.9	width	As per structure 7.12				
5.1.5.10	xml:lang	As per structure 7.27				
5.1.5.11	xml:space	As per structure 7.28				
5.1.6	matimage	An image to be presented.	O	n	PCDATA	The image could be an embedded within the file itself.
5.1.6.1	label	As per structure 7.7				
5.1.6.2	imagtype	The type of image file to be displayed.	O		CDATA string in the form ‘image/****’. As per MIME definitions RFC1521 and Q&TI extensions.	Default set as “image/jpeg”. The Best Practice & Implementation Guide describes the typical range of values.
5.1.6.3	uri	As per structure 7.8				
5.1.6.4	x0	As per structure 7.9				
5.1.6.5	y0	As per structure 7.10				
5.1.6.6	height	As per structure 7.11				
5.1.6.7	width	As per structure 7.12				
5.1.6.8	embedded	As per structure 7.13				
5.1.6.9	entityref	As per structure 7.26				
5.1.7	mataudio (For further study in V2.0).	Audio to be played.	O	n		The embedded audio will be the sampled waveform.
5.1.7.1	label	As per structure 7.7				
5.1.7.2	audiotype	The type of audio file to be played.			CDATA string in the form ‘audio/****’.As per MIME under RFC1521 and Q&TI extensions.	Default setting is “audio/base”. The IMS QTI Best Practice & Implementation Guide describes the typical range of values.
5.1.7.3	uri	As per structure 7.8				
5.1.7.4	embedded	As per structure 7.13				
5.1.7.5	entityref	As per structure 7.26				
5.1.8	matvideo (For further study in V2.0).	Video to be played.	O	n		
5.1.8.1	label	As per structure 7.7				

5.1.8.2	videotype	The type of video file to be played.			CDATA string in the form 'video/****'.As per the MIME definitions under RFC1521 and with Q&TI extensions.	The Best Practice & Implementation Guide describes the typical range of values.
5.1.8.3	x0	As per structure 7.9				
5.1.8.4	y0	As per structure 7.10				
5.1.8.5	height	As per structure 7.11				
5.1.8.6	width	As per structure 7.12				
5.1.8.7	uri	As per structure 7.8				
5.1.8.8	embedded	As per structure 7.13				
5.1.8.9	entityref	As per structure 7.26				
5.1.9	matapplet (For further study in V2.0).	Java applet to be executed.	O	n		Parameters to be passed to the applet being launched should be passed within the CDATA block.
5.1.9.1	label	As per structure 7.7				
5.1.9.2	x0	As per structure 7.9				
5.1.9.3	y0	As per structure 7.10				
5.1.9.4	height	As per structure 7.5				
5.1.9.5	width	As per structure 7.12				
5.1.9.6	uri	As per structure 7.8				
5.1.9.7	embedded	As per structure 7.13				
5.1.9.8	entityref	As per structure 7.26				
5.1.10	matapplication (For further study in V2.0).	An application to be executed.	O	n		Parameters to be passed to the applet being launched should be passed within the CDATA block.
5.1.10.1	label	As per structure 7.7				
5.1.10.2	apptype	The type of application to be executed.	M		As per the MIME definitions under RFC1521.	The IMS QTI Best Practice & Implementation Guide describes the typical range of values.
5.1.10.3	uri	As per structure 7.8				
5.1.10.4	entityref	As per structure 7.26				
5.1.11	matbreak	This causes the flow of the material to have a break inserted.	O	n		The nature of the 'break' insertion is expected to consist of the appropriate combination of linefeed and carriage return.

5.1.12	matref	To pull into scope a material component that is defined elsewhere.	O	n		The referenced material component must be available elsewhere e.g. in the <reference> structure otherwise execution errors will occur. Binding is outside the scope of this specification.
5.1.12.1	linkrefid	As per structure 7.14				
5.1.13	mat_extension	Proprietary material extension.	O		ANY	All extensions to the response-type are to be implemented as sub-elements under this element (see the IMS QTI Best Practice Guide for the naming convention).
5.1.14	altmaterial	Alternative material to be displayed in case the linked material cannot be rendered.	O	n		This alternative material should not be of the same type as the original otherwise it too will not be rendered. Different versions should be used to support other languages or Accessibility options.
5.1.14.1	linkrefid	As per structure 7.14				
5.1.14.2	xml:lang	As per structure 7.27.				
5.1.14.3	qticomment	Comments of the alternative material.	O		As per structure 5.6	
5.1.14.4	mattext	Text to be presented.	O	n	As per structure 5.1.4	
5.1.14.5	matemtext	Text to be presented.	O	n	As per structure 5.1.5	
5.1.14.6	matimage	An image to be presented.	O	n	As per structure 5.1.6	
5.1.14.7	mataudio	Audio to be played.	O	n	As per structure 5.1.7	
5.1.14.8	matvideo	Video to be played.	O	n	As per structure 5.1.8	
5.1.14.9	matapplet	Java applet to be executed.	O	n	As per structure 5.1.9	
5.1.14.10	matapplication	An application to be executed.	O	n	As per structure 5.1.10	
5.1.14.11	matbreak	Insertion of a break in the flow.	O	n	As per structure 5.1.11	
5.1.14.12	matref	To pull into scope material that is defined elsewhere.	O	n	As per structure 5.1.12	
5.1.14.13	mat_extension	Proprietary material extension.	O		As per structure 5.1.13	
5.2	decvar	Declaration of a variable to be used for scoring.	M	n		Each type of variable must be declared before it is used.
5.2.1	varname	As per structure 7.18.				

5.2.2	vartype	The type of variable.	M		Enumerated: String Integer (default) Decimal Scientific Boolean Enumerated Set	Default is set to 'Integer'.
5.2.3	defaultval	The default value for the variable.	O		String 16 chars.	Can be set to any value. Default is set to '0'.
5.2.4	minvalue	The minimum value permitted for a numeric score.	O		String 32 chars.	Applies to the value of the score after all of the item processing has been completed.
5.2.5	maxvalue	The maximum score permitted for a numeric score.	O		String 32 chars.	Applies to the value of the score after all of the item processing has been completed.
5.2.6	cutvalue	The value above which, or equal to, the participant will have been defined to have mastery of the subject.	O		String 32 chars.	The type of this cut value is set by the variable type.
5.2.6	members	The set of enumerated values.	O		String 1024chars.	The set is a comma separated list with no enclosing parentheses.
5.3	setvar	The type of processing to be applied to the variable.	O	n	#PCDATA String 1-1024 chars. The value to be allocated according to the 'Action'.	One must be defined for each variable to be altered due to the condition.
5.3.1	action	The action to be applied.	M		Enumerated: Set (default) Add Subtract Multiply Divide	The default setting is "Set".
5.3.2	varname	As per structure 7.18				
5.4	conditionvar	The criteria to be applied as part of the actual evaluation of the response.	M			Each of the condition provides a boolean test. Consecutive conditions are linked as per the 'and' condition.
5.4.1	varequal	Equivalence test on the variable.	O	n	#PCDATA The comparison value itself.	'True' is returned if equivalent.
5.4.1.1	respident	As per structure 7.19				
5.4.1.2	case	As per structure 7.24				
5.4.1.3	index	As per structure 7.29				

5.4.2	varlt	Less than test of the variable.	O	n	#PCDATA The comparison value itself.	'True' is returned if equivalent.
5.4.2.1	respident	As per structure 7.19				
5.4.3	varlte	Less than or equal test on the variable.	O	n	#PCDATA The comparison value itself.	'True' is returned if the value is less than or equal to the comparator.
5.4.3.1	respident	As per structure 7.19				
5.4.3.2	index	As per structure 7.29				
5.4.4	vargt	Greater than test of the variable.	O	n	#PCDATA The comparison value itself.	'True' is returned if the value is greater than to the comparator.
5.4.4.1	respident	As per structure 7.19				
5.4.4.2	index	As per structure 7.29				
5.4.5	vargte	Greater than or equal test on the variable.	O	n	#PCDATA The comparison value itself.	'True' is returned if the value is greater than or equal to the comparator.
5.4.5.1	respident	As per structure 7.19				
5.4.5.2	index	As per structure 7.29				
5.4.6	varsubset	Test for containment in a list, set, etc.	O	n	#PCDATA The comparison set itself.	'True' is returned if the value is contained within the comparator.
5.4.6.1	respident	As per structure 7.19				
5.4.6.2	index	As per structure 7.29				
5.4.6.3	setmatch	Defines the nature of the set comparison.	O		Enumerated: Exact (default) Partial	The comparison set is a comma separated list with no enclosing parentheses.
5.4.7	varsubstring	Test for containment of a substring.	O	n	#PCDATA The full string.	'True' is returned if the substring (the user response) is contained.
5.4.7.1	respident	As per structure 7.19				
5.4.7.2	index	As per structure 7.29				
5.4.7.3	case	Defines whether or not the comparison is case sensitive.	O		Enumerated: No (default) Yes	No means that the test is case insensitive.
5.4.8	varinside	The XY co-ordinate is inside an area.	O	n	String 4 chars. CDATA of the co-ordinates of the areas: Ellipse x,y,height,width Rectangle x0,y0,height, width Bounded x1,y1, x2,y2,…,xk,yk.	The set of XY co-ordinates defining the area. 'True' is returned if the XY co-ordinate is within the area.
5.4.8.1	respident	As per structure 6.19				

5.4.8.2	areatype	The type of area against which the co-ordinate is to be tested.	M		Enumerated: Ellipse Rectangle Bounded	The ellipse is defined by the values x,y,height,width. The rectangle is defined by the values x0,y0,height,width. The bounded area is defined by the ordered set of pairs of co-ordinates 'x1,y1, x2, y2,…,xk,yk'.
5.4.8.3	index	As per structure 7.29				
5.4.9	var_extension	A proprietary extension facility.	O		ANY	All extensions to the response-type are to be implemented as sub-elements under this element (see the Q&TI Best Practice Guide for the naming convention).
5.4.10	durequal (For further study in V2.0).	Equivalence test on the response duration.	O	n		This is used to test if the response took a particular duration.
5.4.10.1	respident	As per structure 7.19				
5.4.10.2	index	As per structure 7.29				
5.4.11	durlt (For further study in V2.0).	Less than test of the response duration.	O	n		This is used to test if the response took less than a particular duration.
5.4.11.1	respident	As per structure 7.19				
5.4.11.2	index	As per structure 7.29				
5.4.12	durlte (For further study in V2.0).	Less than or equal test on the response duration.	O	n		This is used to test if the response took less than or equal to a particular duration.
5.4.12.1	respident	As per structure 7.19				
5.4.12.2	index	As per structure 7.29				
5.4.13	durgt (For further study in V2.0).	Greater than test of the response duration.	O	n		This is used to test if the response took greater than a particular duration.
5.4.13.1	respident	As per structure 7.19				
5.4.13.2	index	As per structure 7.29				
5.4.14	durgte (For further study in V2.0).	Greater than or equal test on the response duration.	O	n		This is used to test if the response took greater than or equal to a particular duration.
5.4.14.1	respident	As per structure 7.19				
5.4.14.2	index	As per structure 7.29				

5.4.15	not	The logical 'NOT' operator.	O			This inverts the logic of the enclosed elements e.g. not (varequal) becomes the 'not equal to' element.
5.4.15.x	Contains **one** of the following elements: varequal, varlt, varlte, vargt, vargte, varsubset, varsubstring, varinside, var_extension, durequal, durlt, durlte, durgt, durgte, and, or.					
5.4.16	and	The logical 'AND' operator.	O			This provides the AND condition across all of the contained element operators.
5.4.16.x	Contains **two or more** of the following elements: varequal, varlt, varlte, vargt, vargte, varsubset, varsubstring, varinside, var_extension, durequal, durlt, durlte, durgt, durgte, and, or, not.					
5.4.17	or	The logical 'OR' operator.	O			This provides the OR condition across all of the contained element operators.
5.4.17.x	Contains **two or more** of the following elements: varequal, varlt, varlte, vargt, vargte, varsubset, varsubstring, varinside, var_extension, durequal, durlt, durlte, durgt, durgte, and, or, not.					
5.4.18	unanswered	Unanswered condition test.	O			This should be used to trap responses which were not attempted or for which no response is returned.
5.4.18.1	respident	As per structure 7.19				
5.4.19	other	Other condition test.	O			This should be used to trap conditions that are otherwise undefined.
5.5	interpretvar	The interpretation to be applied to the variable in terms relevant to an actor.				At present this element will be a comment string however it will be further developed in version 1.2.
5.5.1	varname	As per structure 7.18				
5.5.2	view	As per structure 7.1				
5.5.3	material	The material used to describe the variables.	O		As per structure 5.1	
5.6	qticomment	The comments used to annotate the XML file.	O			Comments should be used to aid human readability of the XML file itself.
5.6.1	xml:lang	As per structure 7.27				

5.7	duration	The duration permitted for the activity.	O		#PCDATA PnYnMnDTnHnMnS	As defined by the ISO8601. 'n' is an integer used to denote the number of the corresponding time components ('Y'-years, 'M'-months/minutes, 'D'-days, 'H'-hours and 'S'-seconds).
5.8	displayfeedback	The trigger for displaying feedback.	O			
5.8.1	feedbacktype	The type of feedback to be displayed.	M		Enumerated: Response (default) Solution Hint	The default value is 'Response'.
5.8.2	linkrefid	As per structure 7.14				
5.9	outcomes	To create the variables required for the assessment accumulated scores.	M			The assessment/sectionaccumulated and response processing variables group.
5.9.1	qticomment	Comments on the scoring system.	O		As per structure 5.6	
5.9.2	decvar	Declaration of the score variables.	M	n	As per structure 5.2	
5.9.3	interpretvar	Interpretation of the variable comments.	O	n	As per structure 5.5	
5.10	objectives	The objectives of the ASI object.	O	n		These objectives are defined with respect to a view.
5.10.1	view	As per structure 7.1				
5.10.2	qticomment	Comments on the Assessment objectives.	O		As per structure 5.6	
5.10.3	material	The content of the Assessment objectives.	C	n	As per structure 5.1	
5.10.4	flow_mat	Structured material.	C	n	As per structure 5.14	
5.11	rubric	The view specific description of the ASI.	O	n		
5.11.1	view	As per structure 7.1				
5.11.2	qticomment	Comments on the Assessment objectives.	O		As per structure 5.6	
5.11.3	material	The rubric content.	C	n	As per structure 5.1	
5.11.4	flow_mat	Structured material.	C	n	As per structure 5.14	
5.12	qtimetadata	The container for all of the vocabulary-based QTI-specific meta-data.	O	n		Multiple vocabularies can be used for each set of meta-data fields.

5.12.1	vocabulary	The vocabulary to be applied to the associated meta-data fields.	O		#PCDATA String 2048	If no file is used then the vocab can be contained as a comma delimited string.
5.12.1.1	vocab_type	The type of file containing the external vocabulary.	O		String 16 chars.	Default file type is 'text/plain'.
5.12.1.2	uri	As per structure 7.8				
5.12.1.3	entityref	As per structure 7.26				
5.12.2	qtimetadatafield	The structure responsible for containing each QTI-specific meta-data field.	M	n		
5.12.2.1	xml:lang	As per structure 7.27				
5.12.2.2	fieldlabel	The name of the IMS QTI-specific metadata field.	M		#PCDATA String 256	The label should appear in the vocabulary. If no vocabulary is used then external validation cannot take place.
5.12.2.3	fieldentry	Data to be entered for the field identified by the 'fieldlabel' element.	M		#PCDATA String 256	The contents could be bounded by information contained within the vocabulary.
5.13	flow_mat	Similar to material with the blocking guidelines to be applied by the rendering engine.	O	n		The blocking mechanism is render engine dependent.
5.13.1	class	Guidance on the type of block structuring.	O		As per structure 7.25	
5.13.2	material	The content to be displayed.	C	n	As per structure 5.1	
5.13.3	flow_mat	Structured material. This recursive structure allows complex layouts to be constructed.	C	n	As per structure 5.13	
5.14	presentation_material	Contains the material that is to be presented to set the context for the host data structure.	O			This material must be presented to the participant as part of the evaluation.
5.14.1	qticomment	Comments on the presentation material.	O		As per structure 5.6	
5.14.2	flow_mat	Structured material. This recursive structure allows complex layouts to be constructed.	C	n	As per structure 5.13	
5.15	reference	The container for material that is to be referenced by the Sections and/or Items contained within the host structure.	O			
5.15.1	qticomment	Comments of the alternative material.	O	n	As per structure 5.6	
5.15.2	material	Material to be presented.	O	n	As per structure 5.1	
5.15.3	mattext	Text to be presented.	O	n	As per structure 5.1.2	
5.15.4	matemtext	Text to be presented.	O	n	As per structure 5.1.3	

5.15.5	matimage	An image to be presented.	O	n	As per structure 5.1.4	
5.15.6	mataudio	Audio to be played.	O	n	As per structure 5.1.5	
5.15.7	matvideo	Video to be played.	O	n	As per structure 5.1.6	
5.15.8	matapplet	Java applet to be executed.	O	n	As per structure 5.1.7	
5.15.9	matapplication	An application to be executed.	O	n	As per structure 5.1.8	
5.15.10	matbreak	Insertion of a break in the flow.	O	n	As per structure 5.1.9	
5.15.11	mat_extension	Proprietary material extension.	O	n	As per structure 5.1.11	
5.16	material_ref	The reference structure to identify a complete <material> block of content.	O	n		This structure must be used when referencing a complete <material> block.
5.16.1	linkrefid	As per structure 7.14				

5.6 Meta-data Objects

Table 5.6 describes the meta-data objects initially available to the Item objects. None of these structures should be used as they have been deprecated in favour of the QTI-specific meta-data vocabulary approach (see Section 6).

Table 5.6 Meta-data object detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
6.1	qmd_computerscored	Whether or not the Item can be scored by computer.	O		String 4chars. PCDATA	Yes/No entry.
6.2	qmd_feedbackpermitted	Whether or not feedback is available.	O		String 4chars. PCDATA	Yes/No entry.
6.3	qmd_hintspermitted	Whether or not hints are available.	O		String 4chars. PCDATA	Yes/No entry.
6.4	qmd_itemtype	The type of Item used.	O		String 16chars. PCDATA	The options are: "Logical Identifier", "XY co-ordinate", "String", "Numerical" and "Logical Group".
6.5	qmd_levelofdifficulty	The education level for which the Item is intended.	O		String 32chars. PCDATA	The options are: "Pre-school", "School" or "HE/FE", "Vocational" and "Professional Development".
6.6	qmd_maximumscore	The maximum score possible from that Item.	O		Numeric 32chars. PCDATA	An integer or real number.
6.7	qmd_renderingtype	The type of rendering used within the Item.	O	n	String. PCDATA	The options are: "Choice", "Hotspot", "Slider", "String", and "Proprietary".
6.8	qmd_responsetype	The class of response expected for the Item.	O	n	String 16chars. PCDATA	The options are: "Single", "Multiple" or "Ordered".
6.9	qmd_scoringpermitted	Whether or not scoring is available.	O		String. PCDATA	Yes/No entry.

6.10	qmd_solutionspermitted	Whether or not solutions are available.	O		String 4chars. PCDATA	Yes/No entry.
6.11	qmd_status	The status of the Item.	O		String 16chars. PCDATA	The options are: "Experimental", "Normal" or "Retired".
6.12	qmd_timedependence	Whether or not the response are timed.	O		String 4chars. PCDATA	Yes/No entry.
6.13	qmd_timelimit	The number of minutes or an unlimited duration.	O		String 16chars. PCDATA	Either an integer number of minutes or the string "Unlimited".
6.14	qmd_toolvendor	The name of the vendor of the tool creating the Assessment.	O		String 64chars. PCDATA	
6.15	qmd_topic	A brief description of the topic covered by the Item.	O		String 256chars. PCDATA	Text-based description of the Item's topic.
6.16	qmd_material	The type of material used within the Item.	O	n	String 32chars. PCDATA	The style of the list is as per the MIME formats. The full range of text, video, audio, etc. formats used.
6.17	qmd_typeofsolution	The type of solution available in the Item.	O		String 16chars. PCDATA	The options to be used are: “Complete”, “Incremental”, “Multilevel” and “Proprietary”.
6.18	qmd_weighting	The weighting of the Item to be applied to the scoring algorithms.	O		String 16chars. PCDATA	The weighting supplied as a real value.

5.7 Common Data Objects (Attributes)

Table 5.7 describes the data attributes commonly used with the Objectbank, Assessment, Section and Item objects.

Table 5.7 Common attribute detailed description.

No	Name	Explanation	Reqd	Mult	Type	Note
7.1	view	The view to which the interpretation is applied.	O	n	Enumerated: All (default) Administrator AdminAuthority Assessor Author Candidate Invigilator Proctor Psychometrician Scorer Tutor	The ‘All’ view is the default value.
7.2	title	The title of the object.	O		Description String 256	Should be a representative description of the object.

7.3	ident	Unique identity of the object. This should conform to the IMS Persistent Location-Independent Resource Identifier definition.	M		String 32	A unique identifier. See the IMS QTI Best Practice Guide for naming and scoping rules.
7.4	solutionswitch	To enable/disable the provision of solutions.	O		Enumerated: Yes (default) No	Default setting is "Yes". Over-rides all other settings defined within the scope.
7.5	hintswitch	To enable/disable the provision of hints.	O		Enumerated: Yes (default) No	Default setting is "Yes". Over-rides all other settings defined within the scope.
7.6	feedbackswitch	To enable/disable the selection of Feedback.	O		Enumerated: Yes (default) No	Default setting is "Yes". Over-rides all other settings defined within the scope.
7.7	label	A content label.	O		String 256 chars	This label will be used to allow content sensitive search and editing.
7.8	uri	The location of the object.	O		CDATA String 256 chars As per RFC1630.	An alternative to this is the 'entityref' attribute cf. 7.26).
7.9	x0	Top left hand corner x-co-ordinate.	O		CDATA String 4 chars	Aspect ratio is maintained.
7.10	y0	Top left hand corner Y-co-ordinate.	O		CDATA String 4 chars	Aspect ratio is maintained.
7.11	height	The length of the y-axis side.	O		CDATA String 4 chars	Aspect ratio is maintained.
7.12	width	The length of the x-axis side.	O		CDATA String 4 chars	Aspect ratio is maintained.
7.13	embedded	The encoding used for embedded images.	O		CDATA string describing the encoding.	Default setting is "Base64".
7.14	linkrefid	The identifier of the material to be referenced.	M		String 32	Consistency checking is beyond the scope of this specification. Usage rules are given in the IMS QTI Best Practice Guide.
7.15	continue	Next sequence in the processing.	O		Enumerated: Yes No (default)	Default setting is "No".
7.16	rcardinality	The category of the number of responses expected.	O		Enumerated: Single (default) Multiple Ordered	Default is "Single".
7.17	rtiming	Defines if the duration of the user's response is to be recorded.	O		Enumerated: Yes No (default)	Default is "No".

7.18	varname	The name of the variable to be declared. Each numeric variable declared will automatically have the 'x.min" , 'x.max' and 'x.normalised' variables declared.	M		String 16	Default is set as "SCORE". The default includes the automatic declaration of SCORE.min and SCORE.max.
7.19	respident	The identity of the Response type.	M		String 32	The *respident* must have been declared as part of a *response_label*.
7.20	scoremodel	The type of scoring model being adopted.	O		CDATA string describing the model. String 32	Default string is "SumofScores".
7.21	minnumber	The minimum number of responses expected.	O		CDATA String 2 chars	Default value=0.
7.22	maxnumber	The maximum number of responses expected.	O		CDATA String 4 chars	Default value=1.
7.23	feedbackstyle	The manner in which the hint is to be revealed.	O		Enumerated: Complete (default) Incremental Multilevel Proprietary	The default setting is 'Complete'.
7.24	case	Defines the nature of the comparison.	O		Enumerated: No Yes (default)	'No' means case insensitive and 'Yes' means case sensitive.
7.25	class	Guidance to the nature of the flow structure required.	O		CDATA String 32 chars.	The default setting is assumed to be 'Block'. No complete vocabulary has been defined.
7.26	entityref	The entity reference that is used to bind an external file to the XML instance.	O		CDATA string defining the link. String 256.	This is an alternative to the 'uri' attribute (cf. 7.8)
7.27	xml:lang	The language that is being used for the information.	O		String 32.	The language entries will be defined as per the ISO639 and ISO3166 standards.
7.28	xml:space	Space preservation to be maintained or otherwise.	O		Enumerated: preserve default (default)	As per the XML standard.
7.29	index	The ordinal index used by the condition test elements for the response processing.	O		CDATA String 2 chars.	A '1' entry refers to the first user response, '2' the second, etc.

6. Meta-data Descriptions

The meta-data for use with the QTI takes three distinct forms:

- The standard IMS Meta-data that is included in an external description file that is associated with the ASI instance file. An example of this approach is used within the IMS Content Packaging of QTI resources;
- The explicit inclusion of IMS QTI-specific meta-data fields. These fields are included in the 'itemmetadata' elements within the Item data objects;
- The vocabulary based IMS QTI-specific meta-data – this was the new approach introduced as part of the version 1.1 development.

6.1 IMS Meta-data Definitions

There are three sets of meta-data descriptions:

- Assessment – describing the Assessments;
- Section – describing the Sections;
- Item– describing the Items.

In Table 6.1 the entry is defined as either Mandatory ('M') or Optional ('O'). If an entry is defined as 'Fixed' then only the defined value is to be used. The contents and meaning of the *General*, *Life-cycle*, *MetaMeta-data*, *Technical*, *Educational*, *Rights*, *Relation*, *Annotation* and *Classification* are given in the IMS Meta-data Specifications.

Table 6.1 Assessment, Section and Item meta-data list comparison.

Field	IMS Class	IMS Class	Assess Class	Section Class	Item Class
General					
Resource Identifier	A string or number that uniquely identifies this resource.	O	M	M	M
Title	The title of the resource.	O	M	M	M
Catalogue	The catalogue name.	O	O	O	O
Catalogue Entry	The entry in the catalogue.	O	O	O	O
Language	The language the resource is presented in. Default: en-US.	O	M	M	M
Description	A textual description of the contents of the resource.	O	M	M	M
Keywords	On or more exemplifying the contents of the course.	O	O	O	O
Coverage	The coverage of the instructional unit, (use of this field is very experimental).	O	N/A	N/A	N/A
Structure	The structure of the resource. Value: XML.	O	M/Fixed 'XML'	M/Fixed 'XML'	M/Fixed 'XML'
Aggregation Level	The level to which the material is aggregated.	O	O	O	O
Lifecycle					
Version	The version of the resource.	O	O	O	O
Status	The status of the material.	O	O	O	O

Contribute Role	The role of the entity serving as the learning resource: ???Curriculum ???Course ???Unit ???Topic ???Lesson ???Fragment ???NA (Not applicable)	O	N/A	N/A	N/A
Contribute Entity	The entity name for the contribution.	O	N/A	N/A	N/A
Contribute Date/time	The date of the entry of the contribution.	O	N/A	N/A	N/A
MetaMeta-data					
Catalogue	The name of the catalogue being used.	O	N/A	N/A	N/A
Catalogue Entry	The entry in the named catalogue.	O	N/A	N/A	N/A
Contribute Role	The role of the entity serving as the learning resource: ???Curriculum ???Course ???Unit ???Topic ???Lesson ???Fragment ???NA (Not applicable)	O	N/A	N/A	N/A
Contribute Entity	The entity itself.	O	N/A	N/A	N/A
Contribute Date-time	The time of the entity entry.	O	N/A	N/A	N/A
Language	The language the resource is presented in, e.g. en-US. Default: en-US.	O	M	M	M
Meta-data Schema	Information about Meta-data	O	N/A	N/A	N/A
Technical					
Format	The format of the resource, ex. Book, html etc. Value: XML	O	M/Fixed ‘XML’	M/Fixed ‘XML’	M/Fixed ‘XML’
Size	The size of the material.	O	O	O	O
Location	The URL showing where the resource can be retrieved	O	N/A	N/A	N/A
Requirements Type	The type of requirements.	O	O	O	O
Requirements Name	The requirements.	O	O	O	O
Minimum Version	The minimum set of requirements to use this material.	O	O	O	O
Maximum version	The perfect set of requirements to use this material.	O	O	O	O
Installation Remarks	Remarks concerning the installation of the material.	O	O	O	O
OtherPlatformReqs	Other platform requirements.	O	O	O	O
Duration	The expected duration of the materials.	O	O	O	O
Educational					
Interactivity Type	The type of interactivity used by the materials.	O	O	O	O
Resource Type	The type of the resource, ex. Tutorial. Value: Assessment.	O	M/Fixed Assessment	M/Fixed Section	M/Fixed Item

Interactivity Level	The level of interaction between the user and the container ???Low ???Medium ???High	O	N/A	N/A	N/A
Semantic Density	Density of the materials.	O	N/A	N/A	N/A
End-user Role	The intended role of the end-user.	O	O	O	O
Learning Context	The context for the learning materials.	O	O	O	O
Typical Age Range	The age range for whom the materials are relevant.	O	O	O	O
Difficulty	The difficulty of the material.	O	O	O	O
Learning Time	The typical time for completing the materials.	O	O	O	O
Description	A description of the learning materials.	O	O	O	O
Language	The language used for the materials.	O	O	O	O
Rights					
Cost	The price of using a particular offering	Conditional	O	O	O
Use Rights	What a user can do with the offering: Restricted Use Aggregatable Disaggregatable Distributable Editable	O	O	O	O
Description	The description of the rights.	O	O	O	O
Relation					
Kind	The nature of the relationship between the named resource and this resource.	O	O	O	O
Resource	An identifier of a second resource and it's relationship with this resource.	O	N/A	N/A	N/A
Annotation					
Person	The individual making the annotations.	O	O	O	O
Date	The date/time of the annotations.	O	O	O	O
Description	The annotations themselves.	O	O	O	O
Classification					
Purpose	Learning objectives met by the container.	O	O	O	O
Taxon Source	The taxonomy source.	O	O	O	O
Taxon ID	The entry identity under the taxonomy.	O	O	O	O
Taxon Entry	The taxonomy entry itself.	O	O	O	O
Description	A description of the classification.	O	O	O	O
Keywords	One or more words exemplifying the contents of the course.	O	N/A	N/A	N/A

The corresponding Objectbank meta-data entries should be as per the objects contained within the object bank either as per the Sections, the Items or as a mixture of both Section(s)/Item(s).

6.2 IMS QTI-Specific Meta-data Definitions

In previous versions of the IMS QTI the meta-data associated with each of the ASI data objects i.e. was attached using the 'assessmentmetadata', 'sectionmetadata' and 'itemmetadata' elements each of which contained a list of explicitly defined elements for each of the relevant meta-data entries. In V1.2 the 'assessmentmetadata' and 'sectionmetadata' elements have been removed. The 'itemmetadata' element remains to ensure backwards compatibility. However, the usage of the explicitly named IMS QTI-specific meta-data elements is deprecated in favor of the vocabulary approach – see sub-section 6.3.

6.3 QTI-Specific Meta-data Vocabulary

The vocabulary for the IMS QTI-specific meta-data vocabulary is defined in Table 6.2. The vocabulary is supplied as a comma separated list in the text file "imsqtiv1p2_metadata.txt". In Table 6.2 and entry is either optional ('O') or not applicable ('N/A') for the results of a particular evaluation object (Assessment, section or Item result).

Table 6.2 Assessment, Section and Item meta-data list comparison.

Field	IMS Class	Assess Result Class	Section Result Class	Item Result Class
qmd_absolutescore_max	The maximum score that the user may attain (Real number: 1-9999).	O	O	O
qmd_absolutescore_min	The minimum score that the user may attain (Real number: 1-9999).	O	O	O
qmd_assessmenttype	The type of assessment role: Examination Survey Tutorial Self-assessment.	O	N/A	N/A
qmd_computerscored	Whether or not the item can be computer scored [Yes/No].	N/A	N/A	O
qmd_feedbackapermitted	Whether or not the feedback is to be made available. Value: [Yes/No] with default=Yes.	O	O	O
qmd_hintspermitted	Whether or not the hints are to be made available [Yes/No] with default=Yes.	O	O	O
qmd_itemselection	Whether or not Section sequencing is available. Value: [Yes/No] with default=Yes.	O	O	N/A
qmd_itemsequence	Whether or not Item selection is available. Value: [Yes/No] with default=Yes.	O	O	N/A
qmd_itemtype	The type of Item (list including): Logical identifier XY co-ordinate String Numeric Logical group Composite Proprietary	N/A	N/A	O
qmd_levelofdifficulty	The level of difficulty of the Item (list including): ???Pre-school ???School ???Higher/further education ???Vocational ???Professional Development	N/A	N/A	O

qmd_material	Listing of the types of content supplied in the Item: ???Text/basic ???Text/rtf ???Text/html ???Text/xhtml ???Image/gif ???Image/jpeg ???Audio/aicc ???Audio/wav ???Video/quicktime 3 ???Video/quicktime 4 ???Video/avi ???Video/mpeg 1 ???Video/mpeg2 ???Video/mpeg4 ???Applet/java ???Application	O	O	O
qmd_numberofitems	The number of Items directly referenced within the Section.	N/A	O	N/A
qmd_penaltyvalue	The penalty value that is to be used with the 'Guesspenalty' outcomes processing algorithm. This is a number in the range -2^{31} to $2^{31}-1$.	O	O	O
qmd_questiontype	The type of question (list including): True/false Multiple-choice Multiple-response FIB-string FIB-numeric Image hot-spot Drag-and-drop Essay	N/A	N/A	O
qmd_renderingtype	The type of rendering employed (list including): ???Choice ???Hot spot ???Slider ???Text entry ???Proprietary	N/A	N/A	O
qmd_responsetype	The class of responses required by the Item: ???Single ???Multiple ???Ordered ???Proprietary	N/A	N/A	O
qmd_scorereliability	The reliability metric that has been assigned to the score of this evaluation object.	O	O	O
qmd_scorestderr	The standard error that has been assigned to the score for this evaluation object.	O	O	O
qmd_scoretype	The scoring classification: ???Absolute ???Percentage ???Unscored ???Multidimensional	O	O	N/A
qmd_scoringpermitted	Whether or not scoring is enabled. Value: [Yes/No] with default=Yes.	N/A	N/A	O
qmd_sectionselection	Whether or not the solutions are to be made available. Value: [Yes/No] with default=Yes.	O	O	N/A
qmd_sectionsequence	Whether or not Section selection is available. Value: [Yes/No] with default=Yes.	O	O	N/A

qmd_sectionsincluded	Whether or not other Sections are defined within the Section [Yes/No].	N/A	O	N/A
qmd_solutionspermitted	Whether or not the solutions are to be made available. Value: [Yes/No] with default=Yes.	O	O	O
qmd_status	The status of the Item: ???Experimental ???Normal ???Retired.	N/A	N/A	O
qmd_timedependence	Whether or not the user responses are time dependent. Value: [Yes/No] with default=No.	N/A	N/A	O
qmd_timelimit	The number of minutes or an unlimited duration.	O	O	O
qmd_toolvendor	Name of the vendor of the tool creating the Assessments.	O	N/A	O
qmd_topic	A brief description of the topic covered by the Item.	N/A	O	O
qmd_typeofsolution	The type of solution supplied by the Item: Complete Incremental Multilevel Proprietary	N/A	N/A	O
qmd_versionnumber	A string used to define the version number of the object being described. String: 1-255 chars.	O	O	O
qmd_weighting	The weighting of the Item for scoring. Real number: 0.01-10	N/A	O	O

The context for the IMS QTI-specific meta-data is taken from the object in which the meta-data is declared. This means that the context is given as shown by the example below:

```
<questestinterop>
      …
   <section ident="***…***">
      …
      <qtimetadata>
         <vocabulary uri="imsqtiv1p2_metadata.txt" vocab_type="text/plain"/>
         <qtimetadatafield>
            <fieldlabel>qmd_weighting</fieldlabel>
            <fieldentry>2</fieldentry>
         </qtimetadatafield>
         …
      </qtimetadata>
      …
   </section>
</questestinterop>
```

All of the listed meta-data would refer to the results of the identified ‘Section’.

6.4 IMS Meta-data Inclusion

The inclusion of the IMS Meta-data is supported through the usage of the IMS Content Packaging mechanism – more details on this approach is available in the IMS QTI ASI Best Practices & Implementation Guide [QTI, 02b]. However, it should be noted that the resolution of this mechanism is determined by how the ASI objects are packaged i.e. it is **not** possible to label individual Items if the structure is packaged at the Assessment level.

7. Conformance

The purpose of this statement is to provide a mechanism for customers to fairly compare vendors of assessment systems, tools and content. It is **not** required for a vendor to support every feature of the QTI specification, however, a vendor must detail their level of support with a "Conformance Statement". For example vendors may choose to accept or publish QTI data, but not choose to repackage QTI data. Compliance is determined through two documents:

- Conformance summary – this is a summary that shows, in colloquial terms, the capabilities of a particular implementation with respect to the IMS QTI specification;
- Interoperability statement – this is a detailed technical checklist that identifies all of the feature capabilities of the implementation in terms of the QTI specification functions.

7.1 Valid Data Issues

Vendors claiming conformance shall publish, accept, and/or repackage valid QTI data as defined by the DTD including proprietary extensions where applicable. Vendors claiming their tools publish QTI shall export valid QTI data. Vendors claiming their system tools accept QTI data shall be able to parse and recognize valid QTI data. Vendors claiming their system tools repackage QTI data shall be able "pass through" valid QTI data whether the tool recognizes the optional elements or not. Vendors claiming their assessment content conforms to this specification shall provide valid QTI data. Publishers claiming their content conforms to QTI shall provide valid QTI data.

7.2 Conformance Summary

Vendors claiming conformance must provide a "Conformance Summary", detailing their level of conformance, substantially similar to the information shown below, upon a reasonable request from a member of the IMS, a prospective customer(s). It is expected that this table, a template of which is shown in Table 7.1, is a summary of the information given in the 'Interoperability statement'. The intention is for the 'Conformance Summary' to be informative in nature.

Completion of the three columns is intended to reflect:

- Publish – this implies that the XML instance contains the identified elements. If such an element is not ticked then it will not occur within the exported QTI-XML instance(s);
- Accept – it is assumed that the ability to accept the contents of an element is accompanied by the ability to use, and if appropriate, display that content. If this is not the case but the content of the material can be exported then the 'Repackage' column can still be ticked;
- Repackage – this is the ability to import QTI_XML instances from one or more sources and to create a new instance that combines the imported information. It is not necessary for the repackaging system to be able to operate on the information supplied.

7.3 Interoperability Statement

An example of the detailed 'Interoperability Statement' is shown in Tables 7.2a, 7.2b, 7.2c and 7.2d (one for each of the three core data structures. An explanation of how to complete the 'Interoperability Statement' and the relationship between it and the 'Conformance Summary' is given in the IMS QTI Best Practice & Implementation Guide.

Note that the 'Interoperability Statement' addresses support for the various elements within the binding. The set of attributes are not considered. Inclusion of conformance with respect to attributes will be considered in later versions of the specification.

Table 7.1 Conformance summary.

	Conformance Summary (Version 1.2)		
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
Object bank level support	Y or N	Y or N	Y or N
Meta-data	Y or N	Y or N	Y or N
Assessment level support	Y or N	Y or N	Y or N
Meta-data	Y or N	Y or N	Y or N
Objectives, Rubric and Presentation_Material	Y or N	Y or N	Y or N
Outcomes processing	Y or N	Y or N	Y or N
Feedback	Y or N	Y or N	Y or N
Reference	Y or N	Y or N	Y or N
Selection & ordering	Y or N	Y or N	Y or N
Section level support	Y or N	Y or N	Y or N
Meta-data	Y or N	Y or N	Y or N
Objectives, Rubric and Presentation_Material	Y or N	Y or N	Y or N
Outcomes processing	Y or N	Y or N	Y or N
Feedback	Y or N	Y or N	Y or N
Reference	Y or N	Y or N	Y or N
Selection & ordering	Y or N	Y or N	Y or N
Items supported	Y or N	Y or N	Y or N
Meta-data	Y or N	Y or N	Y or N
Question types	Y or N	Y or N	Y or N
Multiple choice	Y or N	Y or N	Y or N
Drag and Drop	Y or N	Y or N	Y or N
Fill in the Blank	Y or N	Y or N	Y or N
Image hot-spot	Y or N	Y or N	Y or N
Objectives & Rubric	Y or N	Y or N	Y or N
Flow	Y or N	Y or N	Y or N
Response processing	Y or N	Y or N	Y or N
Feedback	Y or N	Y or N	Y or N
Hints & Solutions	Y or N	Y or N	Y or N
Material Content	Y or N	Y or N	Y or N
Text	Y or N	Y or N	Y or N
Image	Y or N	Y or N	Y or N
Video	Y or N	Y or N	Y or N
Audio	Y or N	Y or N	Y or N
Other	Y or N	Y or N	Y or N

Table 7.2a Interoperability statement (Objectbank).

Objectbank	Version 1.2		
Mandatory Fields: *All of these fields must be supported.*			
✍ ident			
Optional Fields: *Optional fields are informative. Checking an optional field implies that all of the associated mandatory elements are supported.*			
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
qtimetadata	✍	✍	✍
section	✍	✍	✍
item	✍	✍	✍

Table 7.2b Interoperability statement (Assessment).

Assessment	Version 1.2		
Mandatory Fields: *All of these fields must be supported.*			
✍ ident ✍ section			
Optional Fields: *Optional fields are informative. Checking an optional field implies that all of the associated mandatory elements are supported.*			
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
duration	✍	✍	✍
qtimetadata	✍	✍	✍
objectives material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
assessmentcontrol	✍	✍	✍
rubric material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
presentation_material material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
outcomes_processing outcomes outcomes_condition	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
assessfeedback material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
selection_ordering selection order	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍

reference material	✍ ✍	✍ ✍	✍ ✍
sectionref	✍	✍	✍
Extension Fields: *These features allow the data model to be extended.*			
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
selection_extension	✍	✍	✍
assessproc_extension	✍	✍	✍
outcomecond_extension	✍	✍	✍

Table 7.2c Interoperability statement (Section).

Section	**Version 1.2**		
Mandatory Fields: *All of these fields must be supported.*			
q ident			
Optional Fields: *Optional fields are informative. Checking an optional field implies that all of the associated mandatory elements are supported*.			
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
duration	✍	✍	✍
qtimetadata	✍	✍	✍
objectives material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
sectioncontrol	✍	✍	✍
sectionprecondition	✍	✍	✍
sectionpostcondition	✍	✍	✍
rubric material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
presentation_material material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
outcomes_processing outcomes outcomes_condition	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
sectionfeedback material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
selection_ordering selection order	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍

reference material	✍ ✍	✍ ✍	✍ ✍
section	✍	✍	✍
sectionref	✍	✍	✍
itemref	✍	✍	✍
item	✍	✍	✍
Extension Fields: *These features allow the data model to be extended.*			
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
selection_extension sectionproc_extension outcomecond_extenion	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍

Table 7.2d Interoperability statement (Item).

Item	**Version 1.2**		
Mandatory Fields: *All of these fields must be supported.*			
q ident			
Optional Fields: *Optional fields are informative. Checking an optional field implies that all of the associated mandatory elements are supported*.			
	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
duration	✍	✍	✍
qtimetadata	✍	✍	✍
objectives material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
rubric material flow_mat	✍ ✍ ✍	✍ ✍ ✍	✍ ✍ ✍
itemrubric	✍	✍	✍
itemprecondition	✍	✍	✍
itempostcondition	✍	✍	✍
itemcontrol	✍	✍	✍

presentation	✍	✍	✍
flow	✍	✍	✍
response_label	✍	✍	✍
flow_label	✍	✍	✍
response_lid	✍	✍	✍
response_xy	✍	✍	✍
response_str	✍	✍	✍
response_num	✍	✍	✍
response_grp	✍	✍	✍
render_choice	✍	✍	✍
render_hotspot	✍	✍	✍
render_fib	✍	✍	✍
render_slider	✍	✍	✍
resprocessing	✍	✍	✍
outcomes	✍	✍	✍
decvar	✍	✍	✍
interpretvar	✍	✍	✍
respcondition	✍	✍	✍
setvar	✍	✍	✍
conditionvar	✍	✍	✍
itemfeedback	✍	✍	✍
material	✍	✍	✍
flow_mat	✍	✍	✍
solution	✍	✍	✍
material	✍	✍	✍
flow_mat	✍	✍	✍
hint	✍	✍	✍
material	✍	✍	✍
flow_mat	✍	✍	✍
material	✍	✍	✍
altmaterial	✍	✍	✍
matemtext	✍	✍	✍
mattext	✍	✍	✍
matimage	✍	✍	✍
matvideo	✍	✍	✍
mataudio	✍	✍	✍
matapplet	✍	✍	✍
matapplication	✍	✍	✍

Extension Fields: *These features allow the data model to be extended.*

	Publish (export, data)	**Accept (import, display)**	**Repackage Feature**
response_na	✍	✍	✍
response_extension	✍	✍	✍
render_extension	✍	✍	✍
condition_extension	✍	✍	✍
respcond_extension	✍	✍	✍
itemproc_extension	✍	✍	✍
scorecondition_extension	✍	✍	✍

mat_extension	✍	✍	✍
var_extension	✍	✍	✍

About This Document

Title	IMS Question & Test Interoperability: ASI Information Model Specification
Editors	Colin Smythe, Eric Shepherd, Lane Brewer, and Steve Lay
Version	1.2
Version Date	11 February 2002
Status	**Final Specification**
Summary	This document describes the IMS Question & Test Interoperability Information Model that is used to support question and test interoperability between different authors, publishers and other corresponding content developers.
Revision Information	22 January 2002
Purpose	Defines the IMS Question & Test Interoperability Assessment, Section and Item Information Model.
Document Location	http://www.imsglobal.org/question/v1p2/imsqti_asi_infov1p2.html

List of Contributors

The following individuals contributed to the development of this document:

Russell Almond	ETS, USA
Lane Brewer	Galton Technologies Inc.
Todd Brewer	Galton Technologies Inc.
Russell Grocott	Can Studios Ltd.
Andy Heath	CETIS/JISC, UK
Paul Hilton	Can Studios Ltd.
Steven Lay	University of Cambridge Local Examinations Syndicate, UK
Jez Lord	Can Studios Ltd.
Richard Johnson	Goal Design Inc.
John Kleeman	Question Mark Computing Ltd.
Paul Roberts	Question Mark Computing Ltd.
Nial Sclater	CETIS/University of Strathclyde, UK
Eric Shepherd	Question Mark Corporation
Colin Smythe	Dunelm Services Ltd.

Revision History

Version No.	Release Date	Comments
Final Version 1.0	5 June 2000	The version 1.0 of the IMS Question & Test Interoperability Information Model Final Specification.
Final Version 1.01	22 August 2000	An update of the version 1.0 specification. The core amendments were denoted by a shading of the corresponding lines in the document.
Final Version 1.1	28 February 2001	An update of the version 1.01 specification. The core amendments were denoted by a shading of the corresponding lines in the document.
Final Version 1.2	11 February 2002	The released version of the 1.2 specification. Key amendments are: • The introduction of the exchange of object banks; • The introduction of the <presentation_material> element within the Assessment and Section structures to contain material to be presented to the participant; • The sequence of the contents within the Assessment and Section structures has been altered to better support the required functionality e.g. Section and Items can now be interleaved within a Section; • The metadata elements within the <assessment> and <section> structures that had been previously deprecated have been removed; • The introduction of the <reference> element within the Assessment and Section structures to contain reference material available to the hosted Sections and/or Items; • Introduction of the <outcomes_processing> element reference in the Assessment and Section data structures. This replaces the <assessprocessing> and sectionprocessing> elements; • The introduction of the <selection_ordering> element reference for the Section/Item selection and ordering. This replaces the Item and Section selection and sequencing elements; • Multiple <altmaterial> elements are now supported by the <material> structure and the 'xml:lang' attribute has been added to <altmaterial>; • Introduction of the <material_ref> element to enable reference to a full <material> element structure; • The addition of new attributes to support the <response_grp> element. This allows the possible response groups to be constrained in pairings and number of instantiations; • The addition of the new attribute 'index' to the <varequal>, etc. elements to enable partially ordered condition testing. The <varsubset> element is used to support LID group response processing. The <varsubstring> element is limited to string comparisons only; • The x0, yO, height, width attributes have been added to the <mattext> and <matemtext> elements; • The xml:lang attribute has been appended to a larger range of elements to enable the corresponding language usage to be imposed at various points of the core data objects;

		• Editorial amendments –
		  • Removal of the object-oriented respresentation previously contained in Appendix A
		  • Insertion of a new use-case to reflect interactive content presentation
		  • A reworking of the explanation and structure of Section 4;
		• Error corrections –
		  • The removal of the ‘ident’ attribute on the <presentation> element
		  • The inclusion of the ‘scoremodel’ attribute on the <resprocessing> element
		  • Insertion of the element <qmd_weighting> in Table 5.6
		  • Correct definition of the xml:space attribute.
		The core changes are shown within this document by the shading of the appropriate lines.

Index

D

E