D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

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Executive Summary

In deliverable D6.1, assessment formats were studied from a language-theoretic point of view. In this deliverable D6.2, the analysis is done from a practical, tool-oriented point of view, with particular emphasis on interoperability. More precisely, the objective of this deliverable is twofold. First, to provide an in-depth analysis of interoperability and present a step-by-step procedure for exchanging e-learning material in two open source learning management systems (Moodle and .LRN). This procedure is then framed in the more general evaluation and production flow, which is analysed in order to enhance e-learning material. The first part thus addresses mainly tool developers, whereas the second is focused on final users related to assessment content, particularly content developers or even teachers.

The exchange of assessment material between learning management systems is not a trivial issue. The usage of IMS QTI for this purpose provides us with the advantages of a well-known assessment specification, but with the disadvantages of its complexity (due to its high flexibility) and instability of versions.

A prototype solution has been developed that, making use of IMS QTI 1.2.1, succeeds in this task. Although this solution is not complete, as it just covers a subset of the IMS QTI specification, it serves as a proof of concept for describing the detailed procedure for exchanging material between the two aforementioned open source LMSs (and also with Clix). Thus, users of LMSs have a step-by-step guide to exchange assessment material among these platforms.

On the basis of the experience gained from the development of this prototype, a series of recommendations for assessment interoperability have been proposed. The first part of these recommendations is related to the idea of extending the QTI specification in order to link it to other e-learning fields. This integration brings some benefits, which emerge in the context of e-learning material repositories with several types of content, i.e., learning assessments, units of learning, learning outcomes, etc.

A complete chapter has been devoted to the integration of assessment material in the Open ICOPER Content Space. For that purpose, a prototype is being developed for .LRN that covers a predefined set of assessment scenarios. These scenarios have been defined based on the assessment use cases that are part of the ICOPER Reference Model (IRM). Besides, this prototype implementation is helpful for evaluation of assessment recommendations and the IRM itself.

Additional recommendations are also made about the usage of the IMS QTI specification per se. Nevertheless, to complete these recommendations is still work in progress. They will finally be presented in the last deliverable of Work Package 6.

Regarding production flow, there are no unified procedures to carry it out in the studied European institutions. In addition, the platforms under study (Moodle and .LRN) do not provide support for it. Mechanisms for course evaluation and review are not supported by the platforms, because they tend to implement a more agile content production flow (e.g. the instructors themselves can edit the content in the final production system directly). In order to
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms solve this problem, an example of a production flow and a series of quality assurance parameters have been presented.
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

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1 Introduction

The objectives of this deliverable are to present a step-by-step procedure for exchanging e-learning material in two open source learning management systems (Moodle and .LRN) and to analyse their support for evaluation and production flow in order to enhance e-learning material reuse.

In the second chapter an analysis of the IMS QTI [1] specification has been done from the point of view of interoperability. The IMS QTI complexity is stressed what causes its poor adoption, looking for better practices for its usage.

In the third chapter, the focus is on learning management systems (LMSs) interoperability. A prototype for exchanging assessment material using IMS QTI is introduced, that involves the platforms Moodle [2], .LRN [3] and Clix [4]. Using this prototype solution, the procedure to exchange assessment material between them is step-by-step detailed.

The fourth chapter is devoted to present recommendations for assessment interoperability. Based on the data model concept map, it explains how IMS QTI could be extended in order to include information about other e-learning blocks like instructional design and learning outcomes.

The fifth chapter deals with the integration of assessment materials in the Open ICOPER Content Space (OICS). A series of scenarios based on use cases related to assessment processes are presented. After that, a technical proposal is briefed to allow users to execute assessment processes with the OICS.

The sixth chapter is about e-learning material production flow and evaluation. First, it presents the description of the production flow and some quality assurance parameters to be taken into account. After that, the studied open source platforms (Moodle and .LRN) are analysed in order to determinate their support for production flow, its quality and evaluation. It concludes with a study of production flow and evaluation practices in European institutions. Finally, the last chapter present the conclusions of this interoperability study and present the follow-up actions in this sense.
2 Interoperability analysis of IMS QTI

The IMS Question and Test Interoperability format (IMS QTI or simply QTI) defines a specification for assessment content and results, allowing the exchange of such material between authoring tools, delivery systems, content repositories and LMSs. It is still a specification, because it has not yet been backed by any standardization body. Nevertheless, it has become very popular.

The specification consists of a data model defining the structure of the questions, the tests, feedback and results. An XML binding is provided, which is the most commonly used, that facilitates the exchange of the materials. The formal description of the specification, versions and context were presented in [5].

Despite the completeness of the specification and its acceptance by the industry as the de facto standard, the interoperability is still not achieved completely [6]. There are multiple reasons behind this reality. The most relevant ones are presented as follows.

2.1 Complexity of the specification

A learning management system that wants to be interoperable by means of QTI implements two different functionalities: import and export. Importing a QTI resource means that the platform needs to offer the possibility of seamlessly adding the information to the internal data structures from a given XML file describing a pool of questions or tests. The first difficulty faced in this functionality is the potential incompatibility between the data models. The IMS QTI data model in its 1.2.1 version relies in the following core elements:

- Item: contains a question, its presentation or rendering instructions, the response processing applied to the obtained responses and the feedback, and the meta-data describing the item
- Assessment: contains a collection of items used to determine a level of mastery. It contains instructions to enable different sequences of items and the corresponding scoring instructions.
- Section: contains groups of items to support complex schemes of scoring as well as sequencing.
- Object bank: a collection of items and sections. Its content is searchable.

As it can be seen, this data model already contains important decisions related to the complexity of the specification. This complexity is evenly distributed among all four objects. For example, in the item, the inclusion of rendering instructions, response processing and feedback already implies that the delivery method needs to deal with these issues. The reality, however, is that different platforms may offer different levels of compliance with these aspects thus affecting the level of interoperability.

If an LMS only supports the creation of items, they are rendered trivially as HTML content, and the scoring only allows to know if the question has been answered correctly or not, then
the item object in IMS QTI will have most of its fields empty. This is the reason why most of the data attached to this objects are defined as optional in the specification.

Version 2 of the specification proposed a significant review of the four basic objects in version 1.2.1. The first revision, version 2.0, tackled the review of the first of these objects, the item. The simplification has been significant, but unfortunately, the corresponding tasks for the rest of objects have not been achieved. Version 2.1 is still in draft status. As a consequence, the overall simplification and refinement of the specification to be achieved in version 2 is right now incomplete, and the only complete (and endorsed by IMS) specification is version 1.2.1.

QTI interoperability has been deeply affected by this complexity. If a tool or platform uses a data model with a significant departure from the one proposed in the specification, its capability to inter-operate with other platforms is severely hindered.

When tackling interoperability, a tool vendor or system designer takes the portion of the data model proposed by QTI 1.2.1 that can be directly mapped to the internal data models. This process is done from the inside out, that is, the data model is typically conceived to satisfy the internal requirements of the tools, and then, this model is mapped into the QTI specification in order to check if it can be exported.

This complexity affects equally when tool designers have to implement both the import or export functionality. The most commonly found is the capability to export assessment material in QTI format. Although most tools claim compatibility with this format, the reality is quite different. In the most typical case, tools only export those data items that have a direct mapping on the proposed data model, which in turns, translates into a significant subset.

Regarding the import functionality, the situation is even more complex. When importing assessment material, complying with the entire specification is, in most cases, impossible. Again, the data model and objects included in the specification may refer to aspects that are totally ignored in the data model used in the platform. For example, a QTI assessment may contain sequencing instructions to show sections of an assignment, but the platform may not even have the concept of section, or even worse, the possibility of creating different sequence of items.

The typical approach when this problem is found during an import procedure is to ignore such constructs and import only those portions of the QTI file that, again, have a direct mapping into the data model used in the platform.

The main consequence of this situation is, to say the least, ironic. QTI is expressive enough to capture complex assessment scenarios, and therefore, it is used to export assessment material. However, its flexibility in terms of which information to include becomes its own weakness. The QTI resources produced by one platform are very unlikely to be fully understood by another platform. Most of the content is then lost or partially translated.
2.2 Partial support and QTI-Lite

As a consequence of the aspects described in the previous section, QTI support in most tools is described as partial. This is even more common when the assessment is used for a fairly concrete scenario in which some of the objects in the specification have a very precise role.

This partial support sometimes translates into information that is not properly stored in QTI and thus is lost if the material is imported in a different platform. In other words, the export-import process is not lossless. As a consequence, platforms typically provide an alternative format that successfully maintains the required data to migrate assessment data from one instance of a platform to a different instance of the same platform (that is, two computers running the exact version of the same tool).

The QTI Lite specification appeared as an attempt to bridge this complexity gap. From the initial data model proposed by version 1.2.1, the subset dealing with the item object was extracted and further simplified to obtain the QTI-Lite version of the specification. This restriction, although important because it leaves completely out any information about assessment and sections, still had significant complexity. Response processing is one of the aspects that was kept in QTI-Lite, although with the most simple schemes typically used in a platform.

The support for QTI-Lite is larger due to its simplicity. The compromise that appeared is to reduce the interoperability goals to simply exchange item material, and leave the composition of assessments still as a per-tool process.

2.3 QTI profiles

QTI profiles can be seen as a formal approach to the type of simplification brought by QTI-Lite. The main idea behind a profile is to take the complete specification (version 1.2.1), unequivocally identify a subset that is used in a very concrete scenario, and propose the use of such subset as a profile. When defining the concrete scenario in which a profile is used, the aspects of the generic data model to be ignored are clearly identified. A profile not only contains a subset of a specification, but it can also amend its bindings, thus leaving the door open for a wide range of scopes for the changes.

2.4 Version instability

The current status of IMS QTI poses a significant barrier to increase interoperability. The effort to move from version 1.2.1 (which had an important level of adoption) to the simplified approach hinted by version 2.0 and 2.1 is prolonging itself too much in time. In the meantime, most LMSs and other assessment tools have solved the interoperability problem with ad-hoc solutions that will have a large inertia to adopt future versions of the specification. A reference timeline of the IMS QTI versions was presented in [5].
3 Interoperability among learning management systems

From the point of view of interoperability, the final purpose of the IMS QTI is the scenario of using it for exchanging assessment material among different learning management systems. This type of material may be created in a given institution and then be used in a different course at a different institution. Although the description of this scenario is fairly intuitive, the realization is far from ideal.

Table 1 summarizes the compliance of different eLearning systems with the different versions of QTI. Support for version 1.2 is considerably higher than for the most recent version 2.1.

This is typically justified because of the lack of tools supporting the last version: lack of use reduces the interest of the format as it is intended for facilitating interoperability. This reason is provided for example, in the ATutor Wiki [8], for explaining the lack of support for QTI 2.1 in the tool. In addition, version instability is an aggravating factor. An important percentage of the tools supporting QTI 1.2 do not dare to step forward to the following version, as it is not clear if it is going to be endorsed by the IMS consortium in a close future.

Table 1 IMS QTI compliance in eLearning systems, based on [7]

<table>
<thead>
<tr>
<th>eLearning tools</th>
<th>Import</th>
<th>Export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angel</td>
<td>-</td>
<td>2.1</td>
</tr>
<tr>
<td>ATutor</td>
<td>1.2</td>
<td>1.2, 2.1 (experimental)</td>
</tr>
<tr>
<td>Clix</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>DB Primary</td>
<td>-</td>
<td>2.0</td>
</tr>
<tr>
<td>Diploma</td>
<td>1.2, Lite</td>
<td>1.2, 2.1, Lite</td>
</tr>
<tr>
<td>Dokeos</td>
<td>1.2</td>
<td>1.2, 2.0</td>
</tr>
<tr>
<td>.LRN</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Moodle</td>
<td>1.2</td>
<td>2.0</td>
</tr>
<tr>
<td>OLAT</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>QTI Tools</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td>QuestionMark Perception</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Respondus</td>
<td>-</td>
<td>1.2</td>
</tr>
<tr>
<td>Sakai</td>
<td>1.2</td>
<td>1.2</td>
</tr>
</tbody>
</table>

On the other hand, the data in Table 1 also shows an unbalanced support for QTI 2.X importing and exporting functionalities, some tools do support export to QTI 2.X but cannot import content in that format. The ultimate cause of this problem is the complexity associated to full support of the specification, as discussed in the previous section.

The interoperability capabilities of LMS ultimately depend on the underlying philosophy of design that they have adopted. In some cases, they opt for sticking to a standard or a specification, like IMS QTI, and develop their functionality while improving the standard. In
other cases, however, an ad-hoc format is developed. If the platform is successful, other LMS would have to provide support for the proprietary format, in order to compete with it. .LRN is an example of the first approach. As shown in Figure 1, .LRN uses IMS QTI for internal representation of assessments, relying on such vendor-independent specification for import and export interoperability. Ideally, .LRN should be able to import and export material from and to any other tool compliant with the IMS QTI specification.

Moodle follows the opposite alternative, using a proprietary format for representing assessment content in the platform. Ad-hoc solutions are developed to facilitate interoperability with other systems. A great difference however exists between the formats that Moodle can export when compared to the formats that it is able to import, as shown in Figure 2 and Figure 3.

![Figure 1 Import and export from .LRN](image)
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and LRN) including the required steps to exchange the material in both platforms.

**Figure 2: Formats imported by Moodle**

As shown in Figure 2, Moodle can import multiple formats. It thus facilitates the users migration from other LMS. For this reason, most supported formats are proprietary formats, such as Blackboard, Hot Potatoes or WebCT. The rest of formats that can be imported are the ones used by Moodle itself, like Moodle XML or GIFT, and systems that facilitate traditional assessment methods like Missing Word (fill in the blank). None of the alternatives offered are based on the specification proposed by IMS.

**Figure 3: Formats available for export in Moodle**

Opposite to the import functionality, Moodle offers scarce alternatives for exporting assessment content. Just four options are available: Moodle XML and GIFT (Moodle IMS QTI 2.0, Moodle XML, XHTML).
proprietary formats), XHTML for facilitating the creation of a web page with the assessments and IMS QTI 2.0, the only IMS format supported.

Although assessments can be exported to QTI 2.0, this functionality is not carefully implemented and the generated files do not facilitate interoperability. Problems rise for example when exporting yes/no questions, because no information about the correct answer is included. Other problem is related to the score, that is calculated during the post-processing phase, which makes it difficult detecting if the user has been correct or not.

This design philosophy complicates the interoperability between different systems, because there is no common language supporting the communication and specific solutions are required for each element.

Given the large fragmentation in terms of the formats and tools to solve the problem of assessment in learning management systems, the best procedure to grasp the issues involved is through a case study with concrete tools. It follows the description of the study carried out choosing three learning management systems that were being used by members of the consortium: .LRN, Moodle and Clix. This sample set is representative enough of the different casuistics that may rise in an interoperability scenario.

### 3.1 Problem Statement

An in-depth study with three partners (Giunti, IMC and OUNL) was conducted for analysing the interoperability possibilities between different institutions, analysing the possibilities of assessment exchanging and sharing among the different organizations. A survey was done inquiring about the LMS used in the institution and the importing and exporting capabilities supported by the system for questions and tests. Resulting data configure a scenario which clearly illustrates the interoperability problems existing at present.

<table>
<thead>
<tr>
<th>LMS used in the participant institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moodle</td>
</tr>
<tr>
<td>UC3M</td>
</tr>
<tr>
<td>Giunti</td>
</tr>
<tr>
<td>OUNL</td>
</tr>
<tr>
<td>IMC</td>
</tr>
</tbody>
</table>

Table 2 shows the LMS used in the participant institutions, being Moodle the most used one. Both IMC as well as UC3M work with other systems, such as Clix and .LRN, respectively, which encourages the interest for interoperability between those systems.

<table>
<thead>
<tr>
<th>IMS QTI support in the analysed tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>QTI 1.2</td>
</tr>
<tr>
<td>Moodle</td>
</tr>
<tr>
<td>Clix</td>
</tr>
<tr>
<td>.LRN</td>
</tr>
</tbody>
</table>
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms.

Table 3 summarises the import (I) and export (E) facilities supported by each of the systems. Both Clix and LRN support QTI 1.2. Moodle does not however support importing QTI and only supports exporting QTI 2.0, despite being one of the most successful LMS worldwide, as already stated in the previous section. It should also be emphasized that none of the above mentioned LMS supports the QTI 2.1 draft version.

<table>
<thead>
<tr>
<th></th>
<th>QTI 1.2</th>
<th>QTI 2.0</th>
<th>QTI 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC3M</td>
<td>I/E</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>Giunti</td>
<td>-</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>OUNL</td>
<td>-</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>IMC</td>
<td>I/E</td>
<td>I/E (2010)</td>
<td>-</td>
</tr>
</tbody>
</table>

In consequence, intersecting both tables results in the interoperability possibilities for the partners, graphically represented in Figure 4.

As shown in Figure 4, only the .LRN and Clix platforms can exchange assessment content. Moodle stands however isolated. Nevertheless, as it is the most spread platform, Moodle can exchange assessment information with most institutions, using the proprietary formats available in the system.

3.2 Proposed Solution

3.2.1 Technical basis: format extension in Moodle

Moodle allows extending the accepted formats by adding extensions to the platform. Thus, higher compatibility with IMS QTI specification could be achieved if there exist plug-ins implementing the format. Due to the difficulty of development of such extensions, there are however no available options currently. Presently, a plug-in developed by the Respondus [9] team imports Respondus QTI, which is a subset of QTI 1.2.1, and thus cannot import any file compliant with QTI 1.2.1 DTD. Respondus justifies this design as follows [10]:

"Why is this called a "Respondus QTI" importer rather than just a "QTI" importer? Isn’t QTI an IMS Global standard?"
Over the years, the IMS QTI 1.2 has been implemented in slightly different ways by various vendors. This can occur when there are gaps in a standard or when vendors extend features beyond the standard's specifications. While many vendors have implemented QTI 1.2 in the same way as Respondus, some vendors output versions of QTI that differ in small, but significant ways. The name “Respondus QTI Importer” clearly indicates that the plug-in will work with QTI files that have been exported from Respondus applications. And since Respondus is taking on the technical support for this plug-in, it’s our way of saying that we won’t troubleshoot problematic QTI files that have been generated from other tools. (This is open source, but we can’t do everything for free!)

Moodle proposes a really simple system for adding extensions to the platform, technical details are provided in Annex A.

3.2.2 Architecture

Figure 5 represents the proposed solution for allowing interoperability between all participant platforms and LMSs in the analysed case study.

![Figure 5 Solution for interoperability](image)

Links between Moodle, Clix and .LRN were completed using QTI 1.2.1. This way, a ring was achieved where interoperability is guaranteed. The additional links were implemented based on ability for the extension of formats provided by Moodle, allowing the open platform exporting assessment content to QTI 1.2.1 format. An importing process was added too, but in this case two modules were required. A specific module was developed for each link because a complete support for QTI would have been too generic and complex to be implemented in a single module.

Instead, a specific importer was developed for each system, one for .LRN and one for Clix, which allowed a better fit to the particular characteristics and variations of each platform format.
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

Figure 6 Architecture of interoperability solution for Moodle based on IMS QTI

In summary, four modules were developed for implementing this solution, as shown in Figure 6:

- **QTIexport**: module responsible of the export process of assessment content from Moodle to QTI 1.2.1
- **QTIMoodle**: module able to import the information generated by export processes using QTIexport.
- **QTIlrn**: allows importing QTI 1.2.1 information generated by the .LRN system.
- **QTIclix**: allows importing QTI 1.2.1 information generated by the Clix system.

The implemented solution is nevertheless partial, being restricted to the following types of questions:

- Multiple Choice
- True/False
- Essay

**3.2.3 Procedure to exchange materials between Moodle, .LRN and Clix**

The combination of the architecture described above and the modules developed for Moodle, allows the exchange of assessment materials between the learning management systems that take part in this case study.

In order to provide an integral solution to the problem of sharing assessment materials among LMSs, it is necessary to describe the required step-by-step procedure in order to achieve a successful transition of assessment content from one system to the others. These steps are listed and described as follows.

1. *Creation of assessment material in the source LMS*. This elaboration of material needs to take into account the restrictions regarding the type of questions that can be exchanged. Currently, only multiple choice, true/false and essays question are supported and any created assessment should be restricted to these kinds of items.
2. **Export of assessment material into a QTI 1.2.1 package.** Once the assessment material is completed and ready for a production environment, the material has to be exported as a QTI 1.2.1 package. The export process of an assessment from any LMS is straightforward, by using the export functionality in the respective assessment modules. In this step, users of Moodle should make use of the module QTIexport to generate a package compliant with QTI 1.2.1, and accepted by the other LMSs.

3. **Import of QTI 1.2.1 package to the target LMS.** After the QTI package has been created, the last step in the exchange process is to import this package to the LMS destined to reuse the assessment material. Unlike the export process, the import process depends on the counterpart that participates of the material exchange. .LRN and Clix can import the QTI package by the embedded functionality implemented in their assessment modules. On the other hand, the selection of the functionality to import an assessment into Moodle depends on the source LMS: if the assessment is has been created and exported from .LRN, the QTI must be imported using the functionality implemented in the QTIlrn module, whereas a package exported by Clix must be imported with the QTIClix module functionality.
4 Recommendations to improve assessment interoperability

4.1 Introduction

Nowadays, assessment interoperability is being identified as one of the barriers to overcome in order to facilitate reusability in e-learning environments. Computer-based or computer-assisted assessment systems are tools of great interest. Due to the cost reduction that these systems permit, the possibility of continuous assessment (and feedback) is given. Using computers allows assessment items to be re-used and it is another way to reduce cost and effort.

In pursuance of true interoperability, several specifications have been proposed in recent years, and one of the most popular has been the QTI proposed by the IMS Global Learning Consortium [1]. Although IMS QTI is the specification most commonly used for assessment, its adoption has not been as widespread as expected [3]. Even worse, although it is used in numerous LMSs, due to the ambiguity of its definition, full interoperability when importing and exporting assessment material is by no means guaranteed.

Some of the assessment interoperability problems have been solved during the evolution of the IMS QTI specification. But, the following interoperability issues have been identified in the current versions [6]:

- **Scarce use of the specification:** Some relevant applications do not support QTI because of its complexity. The consequence of it is that QTI is not widely used [11] and, consequently, the interest on using the specification is reduced in the wider educational arena.

- **Flexibility handicaps:** QTI is a very rich specification and allows a large variety of annotations. In order to simplify its adoption, most of these annotations are optional. As a consequence, the format is very flexible and allows developers to omit these elements. At the same time, this flexibility has also proven to be a great obstacle for interoperability. For example, the most common scenario consists on the omission of certain annotations that are not considered important by one tool, whereas another tool considers these annotations essential. For example, QTI format considers optional annotating the correct answer given a question, but some LMS require this information in order to store questions properly. As a consequence, the material exported from one LMS needs to be modified to be compatible with a second LMS (which is precisely what an interoperability specification is trying to avoid).

- **Versions instability:** The last available QTI version, QTI 2.1, is an incomplete draft. So, as a consequence it can be said that the specification has not evolved since 2003 (when version 1.2.1 was released). An additional problem is the lack of compatibility between versions 1.2 and 2.X. Currently, some LMS developers are hoping that the future of QTI is decided, and they continue using the latest endorsed version, QTI 1.2.1.

In this chapter, based on the IMS QTI analysis performed in D6.1 [3] a series of improvements and recommendations are proposed. Thus, the forthcoming proposal is based on:
Assessment concept model
Analysis of IMS QTI specification
Comparison of IMS QTI to other assessment formats
Study of usage of IMS QTI specification in European institutions

4.2 Learning assessment interoperability proposal

The assessment interoperability proposal made in this chapter is twofold: on one hand, a connection to other e-learning concepts has to be achieved; on the other, a set of recommendations to simplify the QTI usage has to be made.

4.2.1 Learning assessment and related concepts

The IMS QTI data model does not include elements for representing or linking to concepts related to other learning aspects of the ICOPER Reference Model (IRM). For example, the unit of learning, the learning outcome or the assessment record are concepts that are related to assessment but not supported by QTI data model. On the other hand, QTI includes information about assessment content, but it does not provide information of learning assessment, like context. Learning Assessment was defined as the process of testing the learning outcomes (knowledge, skills and/or competences) attained by an individual learner and providing the corresponding information reporting about the student achievements and/or potential indications for improving them. As explained in [12], in Higher Education contexts it comprises identifying, collecting and preparing data to evaluate the achievement of program outcomes and program educational objectives.

The integration of assessment concepts and other e-learning process building blocks translates into a series of benefits. For example, the relation of learning assessment to learning outcomes results in the possibility of searching learning assessments in a repository based on the intended learning outcomes. On the other hand, the relation to units of learning stored in a repository results in getting assessment material attached to a specific unit of learning. Finally, the relation to assessment records (through assessment results) is necessary to access grades and feedback achieved by a learner attached to a particular assessment record, e.g., a certificate, and the update the learner profile or PALO (Personal Achieved Learning Outcomes) [13].

In Figure 7, the Learning Assessment (LA) concept has been defined as an entity that contains all the data related to the assessment process. It includes the assessment resources and implements one or more assessment methods. Besides, the Unit of Learning (UoL) is related to the Learning Assessment used in the UoL. Finally, the assessment results (using IMS QTI format) will be normalised into assessment records; this part is still work in progress in the context of ICOPER. The relation between learning methods (that include Teaching Methods and Assessment Methods, that are a special type of them) and the intended learning outcome definitions (LOD) is not going to be developed in the OICS prototype. The main reason is that the real linkage to the learning outcomes is already done from the unit of learning/learning assessment (contextualised versions of the learning methods). The only types of learning outcomes we missed would be the transversal ones (e.g. presentation skills), which are acquired in several UoL/LA, but they are not the main objective of them. An in depth research will be performed to determinate how to deal with this type of learning outcomes.
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms.

Figure 7: Learning outcomes, instructional and assessment concepts

4.2.2 Learning assessment metadata

Given these ideas, the QTI data model should be extended in order to provide it with these connections, as explained in [14]. The new data model should include information of assessment resources, but also define the context and the process of the learning assessment. Two possibilities arose in order to perform this extension:

- Extending QTI (what would be called x-QTI) to include new metadata using QTI current concepts, e.g., the new data will be included in the same QTI file. Besides, a QTI schema should be defined to present this new utilization of elements.
- Using a complementary standard for metadata representation, such as IEEE LOM or Dublin Core, that covers the concepts that QTI does not cover, e.g., relation between learning assessment and a unit of learning. The main problem of choosing this option is that some metadata attributes could be duplicated in the selected standard and IMS QTI.

The second option has been chosen because the extension of QTI should be transparent for the system, i.e., current QTI resources could be reused. For example, a system importing assessment data formatted in x-QTI and not supporting the defined schema should ignore extended data and will import just the assessment content in a proper way. But the current implementations in LMSs could not perform this behaviour.

Due to that, we decided to define the additional metadata using a metadata schema, in concrete, an IEEE LOM profile. The selection of IEEE LOM to represent assessment metadata was based on these reasons:

- It is a mature and widely adopted standard for learning objects metadata and allows connection to other e-learning domain concepts using the Relation attributes (for existing learning objects such as UoLs) and extensions (for non-LOM ones, like LODs).
IEEE LOM relation to IMS QTI: there is a LOM profile defined in IMS QTI 2.X [15] which the learning assessment profile could be based on. IMS LRM 1.3 specification is also supported because it is identified as LOM [16].

Homogeneity with other learning object metadata definitions, i.e., UoLs and TM in D3.1 [17]. In this document, the advantages of using IEEE LOM instead of Dublin Core (DC) or Dublin Core Educational for describing UoL and TM are exposed. Following the same reasoning, Dublin Core proposes a too general set of metadata elements; besides, Dublin Core Educational (a DC application profile for education) requires also some extensions to represent the assessment concepts.

The IEEE LOM profile is already implemented in the OICS thus facilitating compliance and interoperability with other learning aspects.

The LOM profile proposed for ICOPER learning assessment metadata is defined in Annex B. The main concepts of learning assessment are mapped into IEEE LOM profile as follows:

- Learning Assessment is defined by all LOM attributes and categories, including annotations (LOM Learning Resource Type: “Learning Assessment”). The learning resource type “Learning Assessment” is identified as the “Assessment Item” of Resource Discovery Network/Learning and Teaching Support Network (RDN/LTSN) resource type vocabulary [18]. This vocabulary is recommended by in the IMS QTI profile.
- Learning resources are presented as IMS QTI files.
- Assessment Methods are related to Learning Assessment using LOM Relation.
- Units of Learning are related to Learning Assessment through LOM Relation.
- Annotations could be done using the annotation part of LOM. In IMS QTI 2.X [15] there are also mechanisms to define statistics of usage, but they will not be used to make it simpler.
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

An integration of ICOPER work packages 2, 3 and 6 metadata schemas has been also performed, deriving in the schema presented in Figure 8 [19]. It is the result of merging the schemas of learning outcome, instructional models and assessment and will be used as base for OICS prototype developers.

4.2.3 Assessment methods
Another concept not covered by the previous analysis is the assessment method. The assessment method describes the assessment methodology applied, completely specifying all the features that characterise the different dimensions of the assessment process. As explained in [3], there are several dimensions to define assessment methods like:

- Objective: summative or formative assessment.
- Collaboration: individual or collaborative assessment.
- Assessor: instructor-based, computer-based, peer or self-assessment.
- Channel: writing, oral, online, simulation assessment.
- Activity type: collaboration, questions and answers (MCQ, FIB, short answer), etc.

The main relations of this concept in the conceptual map are:

Figure 8: ICOPER LOM profile (work in progress)
• An instance of learning assessment can use one or more assessment methods. For this reason, the LOM Relation element will be used to link both concepts.

• An assessment method (AM) is a specialization of a teaching method (TM). Thus, an AM can be described using the same metadata. Besides, the LOM Educational Learning Resource Type (LRT) for a method instances could be AM, TM or both. Given a learning method, e.g., peer review, it could be considered as a TM and as an AM at the same time. That is the reason to allow multiple learning resource types.

In order to model this concept we will make use of IEEE LOM standard to describe its metadata elements in the OICS. As the assessment method concept inherit from the teaching method concept, the LOM profile used is the same for TM defined in [15].

4.2.4 Evaluation of the proposal

A proof of concept of learning assessment exchanging in a real repository, the Open ICOPER Content Space (OICS), will be implemented in order to validate the proposed data model. Based on IMS QTI analysis, a prototype is being developed and it will be covered in the next chapter.

4.3 Recommendations for improving interoperability using IMS QTI

On the other hand, in order to improve assessment interoperability, a series of recommendations on IMS QTI usage will be performed; this study is work in progress in WP6. A proposal of an IMS QTI profile will be done that will contain just a minimum set of elements that guarantee interoperability, based on the study of usage of the specification and stakeholders’ needs in [3]. For example, features such as adaptive questions and templates are not implemented in the studied LMSs (Moodle and .LRN), so the recommendation will be not to use them.
5 Integration with Open ICOPER Content Space

The solution described in the previous section only solves the problem partially, allowing the users of the three analysed platforms (Moodle, .LRN and Clix) to share information. But if a new platform is considered, it would remain isolated, as the import modules developed for the Moodle LMS are ad-hoc solutions, specifically adapted to the .LRN and Clix systems.

A possible solution would be to use an information repository, such as the Open ICOPER Content Space (henceforth referred to as OICS) [20]. By doing so, assessment content and information could be centralised and the material would be accessible from any other platform. All contents could be downloaded from a single centralised site, thus simplifying the integration of different LMS and interoperability.

In order to realize the exchange of assessment content, a common assessment specification must be used. Although QTI 1.2.1 presents deficiencies and limitations, as previously discussed, it is nevertheless considered a de facto standard by the industry. It is also the most popular version nowadays and the one currently endorsed by the IMS Global Learning Consortium. Thus, this is the specification selected in order to widen the scope of the repository, accomplish universal access and allow it to provide services for both authoring tools as well as LMSs.

One important task is to corroborate that the proposed assessment model fits properly in the ICOPER Reference Model (IRM). It is also needed to validate that the proposed model can support any kind of assessment scenario that a higher education institution may present.

The process to perform this validation consisted of the development of a prototype of an assessment application that connects to the OICS. This prototype would help to demonstrate that the proposed LOM profile provides a proper set of metadata information to exchange and work with learning assessments.

5.1 Scenarios to be supported by prototype application

The design of the prototype for the assessment application was based on a set of assessment scenarios. This set contains three scenarios that involve the use of assessments during the design and enactment phases of a course. The scenarios taken into account for this set are the following:

1. Reuse of assessment materials available in the OICS.
2. Annotation of assessment material by a learning supporter from a LMS.
3. Publication of assessment material to the OICS from a LMS or authoring tool.

In order to provide a broader view of the process to validate the application prototype, an explanation of each one of these scenarios and their implications is presented as follows.

5.1.1 Scenario: Reuse of assessment during design phase

The first scenario is the reuse of an assessment during the Unit of Learning (UoL) design. This scenario is about a learning supporter wanting to plan the learning assessment that takes
part of a UoL. He will search for assessment resources in the OICS according to a series of parameters like:

- the learning outcome type (knowledge, skill, competence)
- intended learning outcomes
- the assessment method (e.g., type - summative, formative, diagnostic; or by assessor: instructor, peer, self or automatic).

The learning supporter could also search resources by language, author/contributor, date, name, description, format (e.g. PDF, MS Word Document), and rights (e.g. CC, GPL).

The workflow of this scenario is described as follows:

1. Search assessment resources. This search can be based on keywords, learning outcomes or assessment methods.
2. Retrieval and review of results. The result view includes this information about the learning assessment: title, language, date, description, format and rights. An example of these results is given to clarify the view of the user (learning supporter).
   - Example: List of assessment resources matching the criteria:
     - Title: Proponents of Communication Theory Essay
     - Intended LOUs: Written expression, Enumerate proponents of communication theory
     - Language: EN
     - Date: 2009-06-01
     - Description: This assessment requires the learner to write an essay about the main proponents in the field of communication theory
     - Format: IMS QTI
     - Rights: CC – BY (Creative Commons - Attribution)
     - Title: Proponents of Communication Theory Test
     - Intended LOUs: Enumerate proponents of communication theory
     - Language: EN
     - Date: 2009-02-01
     - Description: This assessment is a multiple-choice test about the main proponents in the field of communication theory
     - Format: HTML
     - Rights: CC – BY (Creative Commons - Attribution)
3. Selection of assessment resource
4. Import of assessment resource into a course of the LMS

5.1.2 Scenario: Annotation of assessment material
The second scenario is the annotation of assessment resources by any teacher that has used the assessment resource in a real context. This scenario is described as a learning supporter wanting to annotate assessment resources with information of students’ average performance on the assessment. For example, the learner supporter wants to annotate a MCQ with the percentage of students who had selected each of the options. This information can help to detect ambiguous questions and also concepts particularly difficult for the students. Thus, this information can be applied by the learning supporter him/herself or other colleagues during
the planning and design phase of the next course. These annotations contain date and time information, and possibly some data about the course in which the information was gathered.

### 5.1.3 Scenario: Publication of learning assessments to the OICS

The last scenario is the publication of assessment resources to the OICS. In this case, a learning supporter wants to publish assessment resources to the OICS. To do so, the required metadata should be aggregated to the assessment resource. Therefore, the only needed step in the workflow of this scenario consists of describing assessment resources with the corresponding metadata. I.e., including information about intended learning outcomes, assessment method (e.g., type - summative, formative, diagnostic; the assessor: instructor, peer, self or automatic), language, author/contributor, date, name, description, format (e.g. PDF, MS Word document), and rights (e.g. Creative Commons – Share Alike).

One example of this scenario is the following: the assessment author has already created some assessment resources in the LMS (e.g. CLIX). This LMS supports the QTI assessment specification to create and store the resources. When the author decides to share resources he has to annotate them with metadata, e.g., defining LODs, that he is the author and that the assessor for this assessment should be an instructor, because this cannot be done automatically.

### 5.2 Use cases abstracted from scenarios

The scenarios presented in the previous sub-section allow the abstraction of a set of use cases that can be aggregated into two:

- Search of learning assessments
- Publication of learning assessments

These use cases are described in the following sub-sections. A structured description of them is included in Annex C.

#### 5.2.1 Use case: Search of learning assessments

The application prototype, which is being developed as a module of the .LRN LMS, already supports the first use case: search of learning assessments. It also completely fulfills the first scenario described in this section, thus validating the general conceptual model for the exchange of learning assessments in a real scenario.

The implementation of this use case has been possible with a high level of simplicity due to the provision of an intermediate layer between the systems and the OICS. This intermediate layer has been defined as the Middle Layer API and is being documented in the deliverable D1.2 [19]. A simplified diagram of the OICS and prototype intercommunication architecture is shown in Figure 9.
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

Figure 9. OICS and prototype intercommunication architecture

5.2.2 Use case: Publication of learning assessments

Regarding the publication of learning assessments, the architecture and functionality of the OICS permits the publication of learning object metadata in two different ways:

- **PUSH method**, i.e. from the client tools, new contents are sent to the repository.

Advantages:
- Simpler server.
- No new plug-ins are required for each system willing to communicate with the server.
- Information is ready and available since the very moment the client uploads it to the server.

Disadvantages:
- It is not transparent for the user.
- It is not automatic and authors have thus to be trained to upload the content.

In order to develop this platform based on this communication paradigm, an external client should be implemented capable of reading QTI 1.2.1 with metadata. After exporting the content, it would be sent to the client application responsible of uploading the information to the OICS server.

- **PULL method**, the client release the information in a local site, previously configured to be known by the server, and the server gathers the information periodically.
Advantages:

- Transparent for the user.
- A large repository can be easily built.
- No workflow changes are required for the author.
- The server load can be controlled.

Disadvantages:

- Complexity is added to both parts. On the one hand, the server needs to know where and when to search the information. On the other hand, the client must have some method to publish the information and make it accessible for the server.
- Information is not publicly available instantly since its publication.

In order to implement this solution, modules for allowing access to the data or for publishing them in a format supported by the OICS need to be developed.

After analysing the requirements of the prototypes presented previously, it was decided that the most appropriate method to publish and content is the PUSH method, in combination with the use of the Middle Layer API. The implementation of this publication use case is part of the future work at the time of the elaboration of this document.

5.3 Conclusions

The design and implementation of the application prototype, which satisfies the requirements established by the presented scenarios, allow concluding that the proposed conceptual models for learning assessment fulfil the necessities of a real scenario.

The development of the prototype also helped to prove that an application can connect and interact easily with the OICS through the use of the Middle Layer API.
6 Production flow & evaluation of e-learning material

In this chapter, an analysis of LMS (Moodle and .LRN) support for production flow of e-learning material (centred on assessment resources) and evaluation is conducted. Besides, a study has been developed about how European institutions support e-learning material production and evaluation using e-learning tools (LMS).

6.1 Introduction

An idea of what material production flow is has been extracted from [21]. In this document the production stages for Reusable Learning Objects (RLO) are presented. This production flow is described in Figure 12, whose stages are:

- Content creation: Content is created by subject experts using a special template that helps them to organise their materials into a format suitable for RLO development. The template contains sections for activities and assessments. Authors also create the metadata that indexes the RLO.
- Edit: Unnecessarily long words are replaced with shorter ones for a more informal presentational style.
- Peer review (stage 1): This consists of a number of formative evaluation questions that aim to improve the RLO. The peer-reviewer, who is the subject expert's counterpart, is encouraged to be constructively critical and to offer suggestions for improvement where appropriate.
- Media ingredients: These are the images, video clips, audio files, texts, graphs, and spreadsheets etc. - all the components that will be required to make the complete RLO.
- Development: The specification along with the packaged "ingredients" is electronically dispatched to the developer, who builds the RLO from a "kit of parts" consisting of the ingredients and template.
- Tech check: The resulting RLO is checked for functionality at the hub to ensure it works correctly and its appearance and behaviours are consistent. The code is checked for efficiency and to see if it is properly commented. Code chunks are also checked for reusability.
- Peer review (stage 2): The RLO now goes out for the second phase peer-review, usually back to its first stage reviewer. This ensures that it still meets the learning objective and that nothing has been lost in the development process.
- Delivery: The RLO is now indexed and delivered to the web for use and student evaluation.
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms.

**Figure 12: RLO production flow**

In [22], some recommendations are made about quality management of peer production of e-learning content. These recommendations are valid for several scenarios as shown in Figure 13, which cover LMS capabilities and looser approaches (such as blogs, wikis, etc.). In this document the emphasis is put on the firm and controlled scenario of LMSs. Some of these recommendations are that quality assurance should change from product orientation to performance and competence orientation, and from the “learning island” LMS to the Internet as a learning environment.

**Figure 13: Context of peer production from [22]**

Authors in [22] also propose a series of aspects related to quality of tools used in the production flow:

- Access to the tools used: do all potential users have an easy access
- Technical features of the tools: are the tools easy-to-use
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

- Financial impact of the tools: are the tools provided free-of-charge or are there economical limitations for use
- Data security and Intellectual Property Rights: are the tools provided ensuring data security and are their IPR policies clear and acceptable
- Required user support: is user support required and how is it organized
- Longevity of the tools: do we expect that the tools are available in the foreseeable future?

All these features will be analysed in the studied LMS platforms.

6.2 Moodle: production flow and evaluation

In order to describe the production flow of e-learning material in Moodle, an analysis of the platform has been conducted. First of all, the main roles related to production flow and evaluation are presented in [2]:

- Student: user that can enrol to courses. Permissions inside a course depend on course creator, e.g., a student could evaluate other student’s work.
- Course creator: creates courses and grants permissions to participants (teachers, students) in them; has also teacher privileges on created courses.
- Teacher: has privileges to manage course material and students.
- Non-editing teacher: for student mentor or course adjuncts.

Given these roles, the e-learning material is produced by teachers in the context of a course. This material could be of several types: web-based learning content, units of learning, assessment, etc. Each of them are covered by a concrete Moodle module:

- SCORM module: for web-based learning content complying SCORM 1.2 specification (SCORM 2004 is not completely supported).
- IMS CP supported
- IMS QTI: Respondus QTI module for importing QTI content authored using Respondus, that implements a subset of QTI; QTI export module of Moodle quizzes. Another option for running QTI 2.1 assessments is the integration of the ASDEL QTI Playr with Moodle [23].
- Support for IMS CC is in development (maybe a subset of QTI could be supported).

According to production flow quality assurance, Moodle fulfils:

- Access to the tools used: good accessibility by all potential users because it is web-based.
- Technical features of the tools: it is quite easy-to-use.
- Financial impact of the tools: no cost because it is open source and free.
- Required user support: there are a large set of tutorials in [2] to support users and contextual help embedded in the platform.
- Data security and Intellectual Property Rights: it does not provide mechanisms for data security and Intellectual Property Rights.

Regarding course evaluation, teachers can create a Moodle quiz for the end of the course. But a better solution is the use of a third party module (evaluation/polling) that will be included as standard in Moodle 2.0.
6.3 **.LRN: production flow and evaluation**

As in the study of Moodle, first of all the taxonomy of roles in .LRN [3] is presented:

- **Student**: as in Moodle, s/he can participate in courses what implies being taught UoL, doing assessments, filling out evaluation surveys, etc.
- **Staff**: there are several types of staff (Course Assistant, Teaching Assistant, Professor, Course Administrator), all of them with the same privileges: create courses and manage them.

The tools that .LRN provide us for material production flow and evaluation are quite varied: forum, FAQ, wikis, IMS QTI assessment module (QTI 1.2.1 compliant), and IMS LD player (GRAIL, developed by UC3M). It also can manage SCORM and IMS CP content.

According to production flow quality assurance, .LRN fulfils:

- Access to the tools used: good accessibility by all potential users because it is web-based.
- Technical features of the tools: it is quite easy-to-use.
- Financial impact of the tools: no cost because it is open source and free.
- Required user support: there are some unofficial tutorials but not for all features.
- Data security and Intellectual Property Rights: it does not provide mechanisms for data security and Intellectual Property Rights.

Regarding to course evaluation, it is not embedded in the courses, but the assessment and survey modules can support this task.

6.4 **Study of production flow and evaluation in European institutions**

An in-depth analysis of a representative sample of ICOPER institutions has been done in order to determine the current practices regarding production flow and course evaluation. Both quantitative and qualitative studies have been performed, taking advantage of the possibility of analysing in depth the institutions inside ICOPER consortium.

The data presented is from 5 institutions all around Europe: Tallinn University, Télécom & Management SudParis, University of Jyväskylä, Oslo University College, Umea University and Carlos III University of Madrid. The methodology used was a survey about production flow and evaluation practices whose template can be found in Annex D.

The first part of the survey is about e-learning material production flow and evaluation, and the conclusions are:

- There is not a general and global production flow. Each professor is responsible of the learning materials for his/her course, and has complete freedom for producing them.
- Learning materials, activities and assessment resources are created and supervised by the same person (or group of persons).
- Evaluation is mandatory at the end of courses. Students rate course and teachers. Teachers have access to their ratings and comments.

The second part about tools and support in evaluation and production flow:
Several tools are used: LMS (Moodle, .LRN, Fronter [24], IVA [25]) and authoring tools (TATS [26], ADA [27]).

None of the tools provide specific support for integrating the evaluation in the production flow. The reviewer role is not provided by platforms, as would be desirable for quality control because revision is a habitual mechanism in quality assurance.

Although tools support the possibility of defining surveys or questionnaires that could be used for course evaluation, it is not a functionality automatically integrated in the courses.

The conclusions about reuse and exchange material between platforms are:

- There is no common infrastructure or methodology for exchanging assessment material or learning material in general within institutions.
- LMSs support importing and exporting assessment material, but they do not really use this functionality.
- The standards supporting this (lack of) reuse are IMS QTI in LMSs and DocBook in ADA.
- Evaluation results are stored in institutions databases.
7 Conclusions

The exchange of assessment material between learning management systems is not a trivial issue. The usage of IMS QTI for this purpose provides us with the advantages of a well-known assessment specification, but with the disadvantages of its complexity (due to its high flexibility) and instability of versions.

A prototype solution has been developed that, making use of IMS QTI 1.2.1, succeeds in this task. Although this solution is not complete, as it just covers a subset of the IMS QTI specification, it serves as a proof of concept for describing the detailed procedure for exchanging material between the two aforementioned open source LMSs (and also with Clix). Thus, users of LMSs have a step-by-step guide to exchange assessment material among these platforms.

On the basis of the experience gained from the development of this prototype, a series of recommendations for assessment interoperability have been proposed. The first part of these recommendations is related to the idea of extending the QTI specification in order to link it to other e-learning fields. This integration brings some benefits, which emerge in the context of e-learning material repositories with several types of content, i.e., learning assessments, units of learning, learning outcomes, etc.

A complete chapter has been devoted to the integration of assessment material in the Open ICOPER Content Space. For that purpose, a prototype is being developed for .LRN that covers a predefined set of assessment scenarios. These scenarios have been defined based on the assessment use cases that are part of the ICOPER Reference Model (IRM). Besides, this prototype implementation is helpful for evaluation of assessment recommendations and the IRM itself.

Additional recommendations are also made about the usage of the IMS QTI specification per se. Nevertheless, to complete these recommendations is still work in progress. They will finally be presented in the last deliverable of Work Package 6.

Regarding production flow, there are no unified procedures to carry it out in the studied European institutions. In addition, the platforms under study (Moodle and .LRN) do not provide support for it. Mechanisms for course evaluation and review are not supported by the platforms, because they tend to implement a more agile content production flow (e.g. the instructors themselves can edit the content in the final production system directly). In order to solve this problem, an example of a production flow and a series of quality assurance parameters have been presented.
Annex A: Moodle implementation technical details

Moodle proposes a really simple system for adding extensions to the platform; just a new class must be created that inherits from `qformat_default`.

```php
class qformat_qtimoodle extends qformat_default {
}
```

The following functions must be overridden in order to define that a system provides an import or export service.

```php
// Import service
function provide_import() {
    return true;
}

// Export service
function export_file_extension() {
    return ".xml";
}
```

For import processes implementation, the input method is the function `readquestions($lines)`. Where `$lines` is the array of lines for plain text files or a path otherwise.

```php
function readquestions($lines) {
}
```

For modules supporting question exporting, the function `writequestion( $question )` must be implemented. The `$question` variable stores list of questions to be exported.

```php
function writequestion( $question ) {
}
```
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

Annex B: Assessment LOM profile

<table>
<thead>
<tr>
<th>Nr</th>
<th>Name</th>
<th>Size</th>
<th>LOM Element Information</th>
<th>Learning Assessment Metadata Information</th>
<th>Value Space</th>
<th>Datatype</th>
<th>Obligation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>1</td>
<td>This category groups the general information that describes this learning object as a whole</td>
<td></td>
<td></td>
<td>(CATEGORY)</td>
<td>M</td>
</tr>
<tr>
<td>1.1</td>
<td>Identifier</td>
<td>spm=10</td>
<td>A globally unique label that identifies this LO</td>
<td></td>
<td></td>
<td>(CONTAINER)</td>
<td>M</td>
</tr>
<tr>
<td>1.1.1</td>
<td>Catalog</td>
<td>1</td>
<td>The name or designator for the identification or cataloging scheme for this entry. A namespace scheme.</td>
<td></td>
<td></td>
<td>Charstring</td>
<td>M</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Entry</td>
<td>1</td>
<td>The value of the identifier within the identification or cataloging scheme that designates or identifies this learning object. A namespace specific string.</td>
<td></td>
<td></td>
<td>Charstring</td>
<td>M</td>
</tr>
<tr>
<td>1.2</td>
<td>Title</td>
<td>1</td>
<td>Name given to this learning object</td>
<td>Name given to the learning assessment.</td>
<td></td>
<td>Langstring</td>
<td>M</td>
</tr>
<tr>
<td>1.3</td>
<td>Language</td>
<td>spm=10</td>
<td>The primary human language or languages used with this learning object to communicate to the intended user.</td>
<td>Language of the title, description and resources of this learning assessment.</td>
<td>ISO 639:1998 (langcode) and ISO 3166-1:1997 (optional subcode)</td>
<td>Charstring</td>
<td>R</td>
</tr>
<tr>
<td>1.4</td>
<td>Description</td>
<td>spm=10</td>
<td>A textual description of the content of this learning object.</td>
<td>A textual description of this learning assessment.</td>
<td></td>
<td>Langstring</td>
<td>M</td>
</tr>
<tr>
<td>2</td>
<td>Life Cycle</td>
<td>1</td>
<td>This category describes the history and current state of this learning object.</td>
<td></td>
<td></td>
<td>(CATEGORY)</td>
<td>M</td>
</tr>
</tbody>
</table>
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

| 2.1 | Version | 1 | The edition of this learning object. | Version of the learning assessment. | Langstring | O |
| 2.3 | Contribute | spm=30 | Those entities that have contributed to the state of this learning object during its life cycle. | Should at least include the author of the person who created this learning assessment. | (CONTAINER) | M |
| 2.3.1 | Role | 1 | Kind of contribution. | “author” | author | Vocabulary | M |
| 2.3.2 | Entity | spm=40 | Entity or entities contributing to this learning object. | Author details | vCard | Charstring | M |
| 4 | Technical | 1 | Technical requirements and characteristics of this learning object. | Format of the assessment resource included in this learning assessment. | MIME type | Charstring | M |
| 4.1 | Format | spm=40 | Technical datatype(s) of all components of this LO. | Format of the assessment resource included in this learning assessment. | MIME type | Charstring | M |
| 4.2 | Size | 1 | Size in bytes (uncompressed). | Number | Charstring | R |
| 4.3 | Location | spm=10 | Location of the LO. | URL to retrieve the assessment resource. | URL | Charstring | M |
| 5 | Educational | 1 | Key educational or pedagogic characteristics of LO. | Principal environment in which the learning assessment is intended to be used. | higher education | Vocabulary | O |
| 5.6 | Context | spm=10 | Principal environment in which the learning and use of this LO is intended to take place. | Principal environment in which the learning assessment is intended to be used. | higher education | Vocabulary | O |
| 5.9 | Typical Learning Time | 1 | Approximate time it takes to work with or through this LO. | Approximate time it takes to perform this assessment activity. | Duration | R |
| 5.12 | LearningOutcome | spm=30 | LOM EXTENSION | References and qualifies a learning outcome evaluated at by this | (CATEGORY) | R |
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Rights</td>
<td>1</td>
<td>IPR and conditions of use.</td>
<td>(CATEGORY)</td>
</tr>
<tr>
<td>6.3</td>
<td>Description</td>
<td>1</td>
<td>Comments on the conditions of use of this LO.</td>
<td>Comments on the conditions of use of this learning assessment.</td>
</tr>
<tr>
<td>7</td>
<td>Relation</td>
<td>spm=100</td>
<td>Relationship between this LO and other LOs.</td>
<td>Links between this learning assessment and the assessment method(s) it implements.</td>
</tr>
<tr>
<td>7.1</td>
<td>Kind</td>
<td>1</td>
<td>Nature of the relationship</td>
<td>Use to link to assessment methods that this learning assessment implements.</td>
</tr>
<tr>
<td>7.2</td>
<td>Resource</td>
<td>1</td>
<td>Target object of this relationship</td>
<td>(CONTAINER)</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Identifier</td>
<td>spm=10</td>
<td>A globally unique label that identifies the target LO</td>
<td>(CONTAINER)</td>
</tr>
<tr>
<td>7.2.1.1</td>
<td>Catalog</td>
<td>1</td>
<td>Name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.</td>
<td>Cataloguing scheme of target resource</td>
</tr>
<tr>
<td>7.2.1.2</td>
<td>Entry</td>
<td>1</td>
<td>Value or identifier within the catalogue. A namespace specific thing.</td>
<td>Entry within catalogue</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Description</td>
<td>spm=10</td>
<td>Description of the target LO</td>
<td>Description of the target resource</td>
</tr>
<tr>
<td>8</td>
<td>Annotation</td>
<td>spm=30</td>
<td>Use for annotation / comments on: TEACHER REFLECTION, STUDENT FEEDBACK, PEER REVIEW</td>
<td>(CONTAINER)</td>
</tr>
<tr>
<td>8.3</td>
<td>Description</td>
<td>1</td>
<td>Content of this</td>
<td>Content of this comment</td>
</tr>
</tbody>
</table>
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and LRN) including the required steps to exchange the material in both platforms

<table>
<thead>
<tr>
<th>annotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.4</td>
</tr>
<tr>
<td>Type</td>
</tr>
</tbody>
</table>
Annex C: Definition of Use Cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Search of Learning Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Search learning assessments published by the OICS, that match with certain conditions.</td>
</tr>
<tr>
<td><strong>Actors</strong></td>
<td>Learning supporter</td>
</tr>
<tr>
<td><strong>Preconditions</strong></td>
<td>• The LMS or system being used by the learning supporter is able to connect and fetch information from the OICS.</td>
</tr>
<tr>
<td><strong>Steps</strong></td>
<td>1. The learning supporter provides a short query to search the learning assessments.</td>
</tr>
<tr>
<td></td>
<td>2. The system fetches a list of the learning assessments that fit the best with the query provided. This list is presented to the learning supporter.</td>
</tr>
<tr>
<td></td>
<td>3. The learning supporter reviews the list of assessments and can review the details of a specific one.</td>
</tr>
<tr>
<td></td>
<td>4. The learning supporter can fetch and import the learning assessment that is considered the most appropriate one for the course being designed.</td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td>The learning supporter successfully imports the learning assessment that fits the best with the needs of the course.</td>
</tr>
<tr>
<td><strong>Variations</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Non-Functional</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Publication of Learning Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Publishing learning assessments created in the local system to the OICS.</td>
</tr>
<tr>
<td><strong>Actors</strong></td>
<td>Learning supporter</td>
</tr>
<tr>
<td><strong>Assumptions and Conditions</strong></td>
<td>• The LMS or system being used by the learning supporter is able to connect and send information to the OICS.</td>
</tr>
<tr>
<td></td>
<td>• The learning supporter has already created a complete assessment resource in a system that is able to export that material into a QTI package.</td>
</tr>
</tbody>
</table>
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

| Steps | 1. The learning supporter provides the metadata required to publish the learning assessment.  
2. Once the metadata information is complete, the learning supporter sends the assessment to the OICS through the authoring tool or LMS. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>The learning supporter successfully publishes the learning assessment to the OICS and this becomes available for other tools connected to the OICS.</td>
</tr>
<tr>
<td>Variations</td>
<td>-</td>
</tr>
<tr>
<td>Non-Functional</td>
<td>-</td>
</tr>
<tr>
<td>Remarks</td>
<td>-</td>
</tr>
</tbody>
</table>
Annex D: Survey on Evaluation and Production Flow Practices template

Survey on Evaluation and Production Flow Practices

Context

Study of current support for evaluation and production flows in the main open source e-learning platforms such as Moodle or .LRN.

Questions

Describe the evaluation and production flow in your institution.

What tools (LMSs) are used in your institution?

How is evaluation supported in these tools? What is their impact in the production flows of generic e-learning material?
Please specify the level of reuse and the possibilities for exchanging evaluation material in your institution. Have you got any experience of exchanging material between different platforms (LMSs)?

Detail any standards used for supporting this production flow.

Name and institution:  .................................................................
D6.2 – Production flow description and prototype for the two platforms under study (Moodle and .LRN) including the required steps to exchange the material in both platforms

References

D6.2 – Production flow description and prototype for the two platforms under study (Moodle and LRN) including the required steps to exchange the material in both platforms


[27] ADA, http://www.it.uc3m.es/abel/ADA/doc/FAQ.html