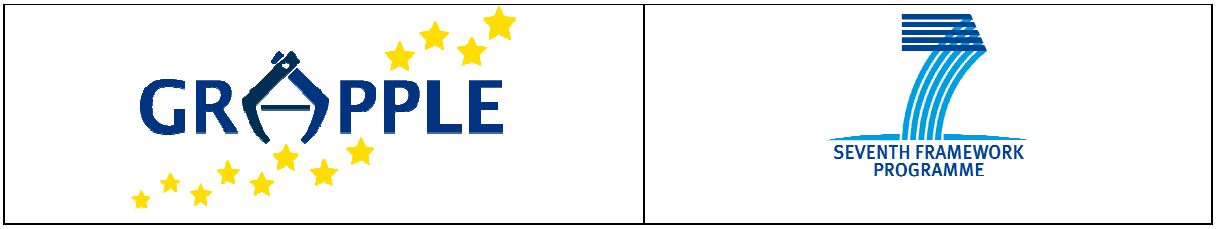

# GRAPPLE

D5.3b Version: 1.0

## Analysis, modelling and implementation of use cases and templates with IMS-LD

| | |
|---|---|
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| **Author(s):** | Daniel Burgos (ATOS), Noaa Barak (ATOS) |
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**Abstract:** This deliverable follows the research started in D5.3a. In the previous deliverable we showed the background about IMS Learning Design and how to model adaptive learning with this specification. In addition, we provided a first set of Learning Scenarios which express adaptation based on various inputs, and which were modelled with IMS Learning Design. In D5.3b, we extend this research. We provide a thorough analysis of a number of use cases which have been designed based on research in D5.3a. We describe the adaptation carried out and how it has been modelled. As a result of these use cases and analysis, we provide a detail list of issues to be modified and improved in the specification to better express adaptation. In addition, we show an application case developed and implemented in an Industry setting, and based on this ongoing research. Last, we provide a set of templates (Learning Process Components) ready to be used and integrated into new Learning Scenarios. All these outcomes (i.e. use cases, application case, templates, and structured analysis) will be used as a fundamental input in D5.3c, in which we will provide recommendations and extensions to IMS Learning Design to improve its expressiveness of adaptive and adaptable learning.

**Keyword list:** IMS Learning Design, Use Case, Unit of Learning, Template

# Summary

The work presented in this deliverable summarises the research performed within task 5.3 in order to implement a set of Units of Learning (UoLs) focused on adaptive learning processes, using the specification IMS Learning Design (IMS-LD). Through the implementation and analysis of four use-cases, and an additional application case, we identify a number of constraints on the use of IMS-LD to support adaptive learning. Our work in this deliverable shows how IMS-LD expresses adaptation, which is modelled following the background and guidelines provided in D53.a. In addition, our research presents a number of elements and features that should be improved and-or modified to achieve a better support of adaptation for learning processes. Deliverable 5.3c, the next to be produced by task 5.3, will use the work carried out to suggest extensions and modifications of IMS-LD with the final aim of better supporting the implementation of adaptive features.

# Authors



| Person | Email | Partner code |
|---|---|---|
| **Daniel Burgos** | Daniel.burgos@atosresearch.eu | ATOS |
| **Noaa Barak** | Noaa.barak@atosresearch.eu | ATOS |



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# List of Acronyms and Abbreviations

| | |
|---|---|
| ALE | Adaptive Learning Environment |

| | |
|---|---|
| GRAPPLE | Generic Responsive Adaptive Personalized Learning Environment |
| IMS | IMS Global Consortium |
| IMS-LD | IMS Learning Design specification |
| LMS | Learning Management System |
| CAM | Conceptual Adaptive Model |
| CP | Content Packaging |
| SS | Simple Sequencing |
| QTI | Question and Test Interoperability |
| LIP | Learner Information Package |
| SCORM | Sharable Content Object Reference Model |
| ADL | Advanced Distributed Learning |
| SCO | Sharable Content Object |
| VLE | Virtual Learning Environment |
| RTE | Run-Time Environment |
| SN | Sequence and Navigation |
| UoL | Unit of Learning |

# 1 Task and Deliverable Description

**T 5.3 Modelling with and Extending IMS-LD** (ATOS, OUNL, UCL, UCAM, GILABS)

Analysis and modelling of adaptive IMS-LD UoLs showing adaptive features with identification of gaps between the theoretical approach and the practice. In addition, this task will carry out an implementation of a complete set of use cases and templates showing the different findings and creations. Concrete adaptive learning material will be converted between LMSs so that they can be used in evaluation experiments in WP9 and WP10. Training material for importing, exporting and converting adaptive learning material will be prepared for use in WP11.
The study of IMS-LD may lead to proposals of extensions and modifications of IMS- LD, other specifications and some relevant LMSs to support the best implementation of adaptive features. When deemed appropriate we will start negotiations with standardization bodies and supporting institutions.

**D5.3a Analysis, modelling and implementation of IMS-LD UoLs** (ATOS, M18)

A full and solid set of UoLs developed with IMS-LD will be modelled to show specific features of adaptation, expressed in CAM, and to identify shortcomings and possible ways of improvement in the specification. In addition, a rich repository of use cases and templates will be developed (M24), ready to use by end users (authors) dealing with adaptive learning, and needing to integrate their adaptive learning material in an LMS.

**D5.3b Analysis, modelling and implementation of use cases and templates with IMS-LD** (ATOS, M24)

Following up the work in D5.3a, a rich repository of use cases and templates will be developed, ready to use by end users (authors) dealing with adaptive learning, and needing to integrate their adaptive learning material in an LMS.

**D5.3c Extensions and modifications of learning specifications and LMSs focused on adaptive learning** (ATOS, M30)

Based on D5.3a and D5.3b input a set of extensions and modifications will be defined and delivered, very much focused on improving the expressive power of IMS-LD for adaptive learning

# 2 Introduction

Deliverable 5.3b is composed of both a report and a prototype. In this context, the prototype consists of a set of UoLs (UoLs), meaning a number of use cases modelled with IMS Learning Design. Both outcomes describe the research carried out within task 5.3 in order to express and model adaptive learning processes with the IMS Learning Design specification.

Previously, in deliverable 5.3a, we have described how adaptation is envisaged by IMS-LD and which types of adaptation can be expresses with this specification. Furthermore, we have described, modelled and implemented a number of Learning Scenarios which show adaptation features.

A brief overview of these scenarios is presented in the beginning of this document. Next, we define, model and analyse a number of UoLs, modelled as use cases, and corresponding to the aforementioned scenarios. In these use cases, we describe adaptive learning processes and features. Further, we bring an analysis of a real application case from the ATOS University, where a Unit of Learning (UoL) with adaptation features modelled with IMS-LD, was implemented. Through this work, we design, produce and deliver specific templates of Learning Process Components ready to be used by an end-user. Although IMS-LD is able to express adaptive learning processes, it shows a number of drawbacks and restrictions to model some types of adaptation.

In conclusion, we present the second step of the research carried out in Task 5.3, which is focused on the main challenges and limitations to performing adaptive learning with IMS-LD. These mainly focus on the need for improving the flexibility and interoperability of this specification, while modelling adaptation.

# 3 Connection to other Work Packages, Tasks and Deliverables

Taken from the GRAPPLE Description of Work (DoW), the following diagram (Figure 1) shows the interdependency between the different GRAPPLE WPs.

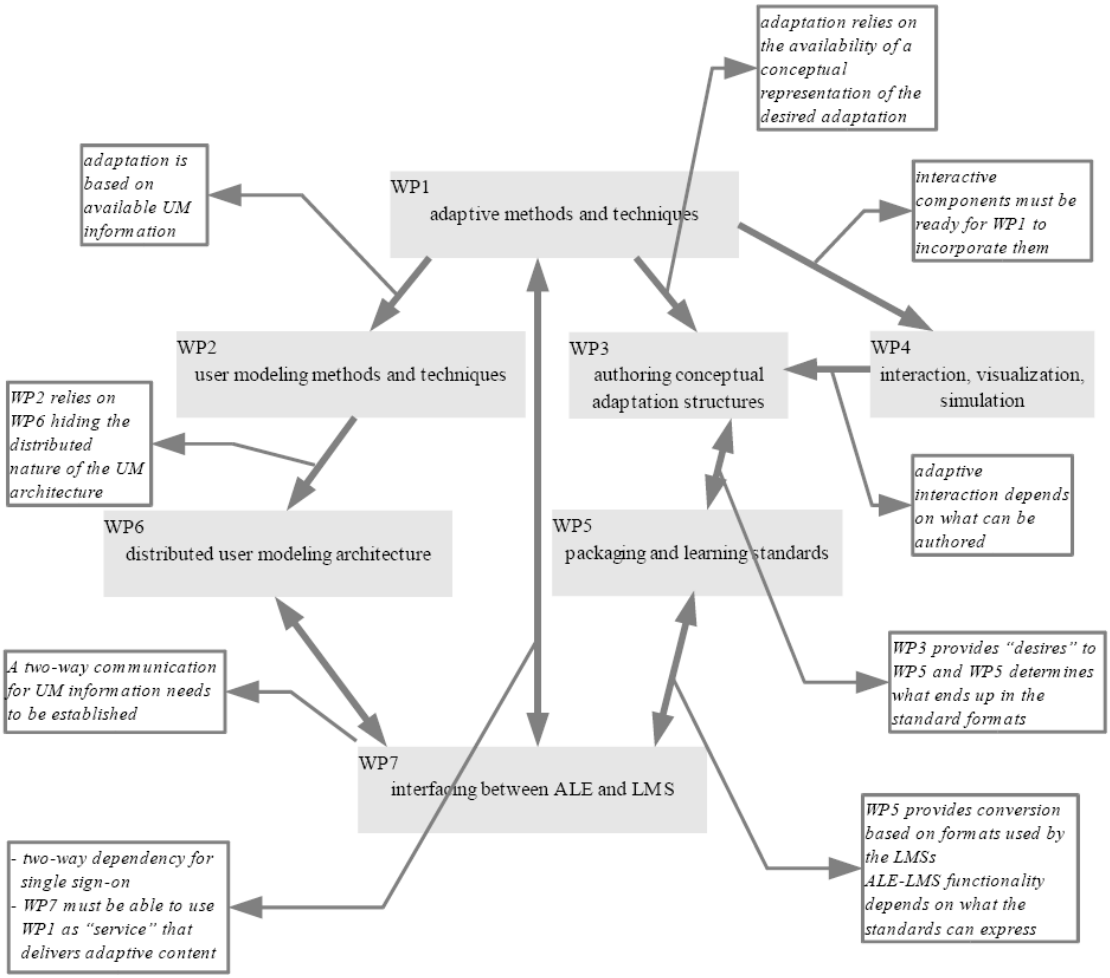


Figure 1. Interdependency between the different GRAPPLE WPs

As presented in the diagram above, WP5 is mainly connected to WP3 and WP7. In general, the focus is on matching the needs for expressing adaptation in learning materials and processes (essentially Conceptual Adaptive Models (CAMs) created in WP3) within the capabilities and properties of existing specification frameworks like IMS-LD, possibly with extensions, so that these standards can be used within the Grapple framework (WP7). However, while performing the work described in this deliverable, we have also relied on work performed by WP2 and WP6, especially with regards to user modelling and CAM.

Deliverable 5.3b is closely linked to the previous deliverable 5.3a, which describes the adaptive Learning Scenarios we turned into UoLs in this report, and lays the basis for deliverable 5.3c, to be released on month 30. D5.3c will explore the connection between IMS Learning Design and CAM, so that IMS-LD expressiveness and methodology can be used in Grapple, and the other way around.

The interaction between WP5 and WP3 results in an understanding of the various inputs, roles, interactions, adaptation methods & techniques which are feasible within the limits of the explored standards. The interaction between to WP5 and WP7 results in the implementations done by WP7 of the theoretical LMS-based conversion models described by WP5.

Specifically, deliverable D5.3b will be mainly considered by the future deliverables expected in WP3 (D3.2c, D3.3c, D3.4c and D3.5c) and in the final release of the operational infrastructure in D7.5. Through these deliverables in WP3 and WP7, D5.3b will also impact the last cycle of evaluation actions in WP9 and WP10.

# 4 From a Learning Scenario to re-usable resources

## 4.1 Brief reminder on basic Learning Scenarios

Every scenario in this section is explained according to the several taxonomies, theories and guidelines provided in **D5.3a Analysis, modelling and implementation of IMS-LD UoLs**, which also analyze the Conceptual Adaptation Models in WP3. All of them are available at the Grapple website, at [http://www.grapple-project.org]. Furthermore, we summarize the Learning Scenarios already described in D5.3a, which will be used as a based to build re-usable resources, in the form of use cases and templates, to be presented afterwards. Therefore, extended information about the following Learning Scenarios can be found in D5.3a.

Furthermore, these Learning Scenarios show various types of adaptive learning according to the analysis provided in D5.3a. All these scenarios require and model one or several adaptation strategies, which have been summarized in the heading "Type of adaptation", in every scenario description, provided below. In addition, they become a basic set to re-use existing resources, since they will evolve from Learning Scenarios to use cases which will provide the base for a thorough analysis about IMS-LD and adaptation, as it will be shown later on in this deliverable.

### 4.1.1 Learning Scenario 1. Making a project proposal

**Type of adaptation:** Adaptive mentoring

**Roles**: tutor, learner/s

**Learning Categories**: Understanding, Evaluating, Creating, Analysing

**Learning Strategies**: Monitoring and Regulating, Support from others, Elaboration, Study-environment

**Name of the Unit of Learning**: Making a project proposal

**Description**: a group of Junior Consultants in an international company has been tasked to prepare a new proposal for an EU FPVII project. They will work on peer basis with an Area Manager who will lead them on the right process of redaction

### 4.1.2 Learning Scenario 2. A new skill

**Type of adaptation:** Self-evaluation, Learning path, Performance

**Roles**: learner, set of rules

**Learning Categories**: Understanding, Evaluating

**Learning Strategies**: Meta-cognitive, Elaboration, Rehearsal

**Name of the Unit of Learning**: Geo Quiz 3

**Description**: an officer of the Postal Office needs to learn how to use a new digital system that replaces the old analogical one. (S)he will use a set of quizzes to check his/her knowledge, based on previous information. Depending on the performance the learning path will be adapted to support the best study progress

### 4.1.3 Learning Scenario 3. Human resources live

**Type of adaptation:** personalised evaluation, Runtime tracking

**Roles**: learner, set of rules, tutor

**Learning Categories**: Evaluating, Creating

**Learning Strategies**: Cognitive, Meta-cognitive, Support from others, Planning, Effort

**Name of the Unit of Learning**: Quo Builder 2

**Description**: a human resources responsible, who has to create a quiz for a course, has to adapt it as long as the course takes place (in the runtime). This quiz allows for a better Adaptation to the users´ needs along the learning flow. Since there is almost no distinction between design time and run time, learning goals, objectives and content can be easily adapted on the run

### 4.1.4 Learning Scenario 4. Learning at the workplace

**Type of adaptation:** personalised learning itinerary, Learning strategy

**Roles:** learner

**Learning Categories**: Understanding, Remembering

**Learning Strategies**: Meta-cognitive, Elaboration, Monitoring and Regulating, Organizational

**Name of the Unit of Learning**: Candidas II. The Great Unknown

**Description**: a young paramedic who has to learn on the run at the workplace about new treatments for diseases. The course consists of a series of sections with relevant information for his/her knowledge upgrade. The learner can choose the learning strategy that fits better with his/her behaviour and objectives, out of four different possibilities. Every choice deploys a contextualized learning itinerary

### 4.1.5 Learning Scenario 5. Getting some expertise

**Type of adaptation:** personalised learning itinerary, Self-evaluation, Learning style

**Roles**: learner, set of rules

**Learning Categories**: Remembering, Understanding, Applying, Analysing, Evaluating

**Learning Strategies**: Cognitive, Meta-cognitive, Study-environment, Organizational

**Name of the Unit of Learning**: Learning to Listen to Jazz

**Description**: a librarian needs to acquire some knowledge on Jazz Styles when (s)he is appointed to another position in the Music Section. A rich course with the requested information to get some important expertise on this topic is provided to the librarian. (S)he can adapt the learning itinerary according to his/her learning style and preferences. Related to every itinerary there are a set of self-evaluations that provide some formative and summative feedback

## 4.2 Definition, analysis and modelling of use cases based on basic Learning Scenarios

The following use cases have been designed and modelled, based on the aforementioned Learning Scenarios. While those Learning Scenarios showed the foundations for adaptive learning processes which were modelled with the IMS Learning Design specification, these use cases follow the basic concepts and structures provided in D5.3a, and make re-usable resources, ready to be implemented and personalised for a specific context. Furthermore, we show the key parts and structures of the actual modelling process in IMS

Learning, which highlight how this specification addresses the challenges on effective adaptation. Last, every use case is analysed and reports on shortcomings and recommendations to improve the expressiveness of IMS Learning Design to achieve a better adaptation process. These partial outcomes will feed into the next deliverable (D5.3c), which will provide a detailed and structured report to modify and extend this specification.

In addition, we present an application case developed for the ATOS University (http://www.atosuniversity.com/), for internal corporate training. This application case has been designed and modelled following the criteria, methodology and Learning Scenarios described and implemented in this WP5 of the Grapple project. Currently, we are analysing the raw data from this experience, which will provide a detailed report in D5.3c.

General references about understanding, modelling and using IMS Learning Design, in general, and oriented to adaptive learning processes, can be found at the end of this deliverable, section “References”.

### 4.2.1 Use case: adaptation on the learner’s performance and knowledge: Adaptive Assessment

**File name**: ATOS-AdaptiveAssessment.zip

**Based on**: Learning Scenario 2. A new skill

*Every use case that we show from now onwards has been modelled using the simple text editor NotePad and the XML editor XMLSpy, and they have been published and executed with CopperCore 3.0 [http://www.coppercore.org]. CopperCore is an open source engine and player specifically designed to publish, interpret and play IMS-LD UoLs. Currently, it is the only one system capable to deal with the required components which make possible adaptive learning processes.*

*Afterwards, all of them have been revisited using several IMS-LD Editors, like i.e. CopperAuthor, Cosmos, Reload IMS-LD Editor and ASK LDT, although none of them provide with a friendly, high-level interface that could help on modelling.*

The UoL **Adaptive Assessment** is focused on adaptation based on the performance and the previous knowledge of the learner (Figure 2). First, the learning designer has to define the set of rules that manage the learner’s status. The flow basically adapts the next action to take after a quiz is fulfilled. Depending on the answers and on the threshold to achieve, one or another activity is turned on, what actually means that the learner reaches a different, adapted level. The learning designer defines a set of questions and answers and three possible outcomes, meaning one activity per outcome. Although firstly hidden, after the questionnaire one of the three possible activities is shown. No interaction with a teacher is established. We will use this use case as a base to build upon. The rest of the case studies will show punctual contributions to this very detailed example. Below, we show the key parts of the code.

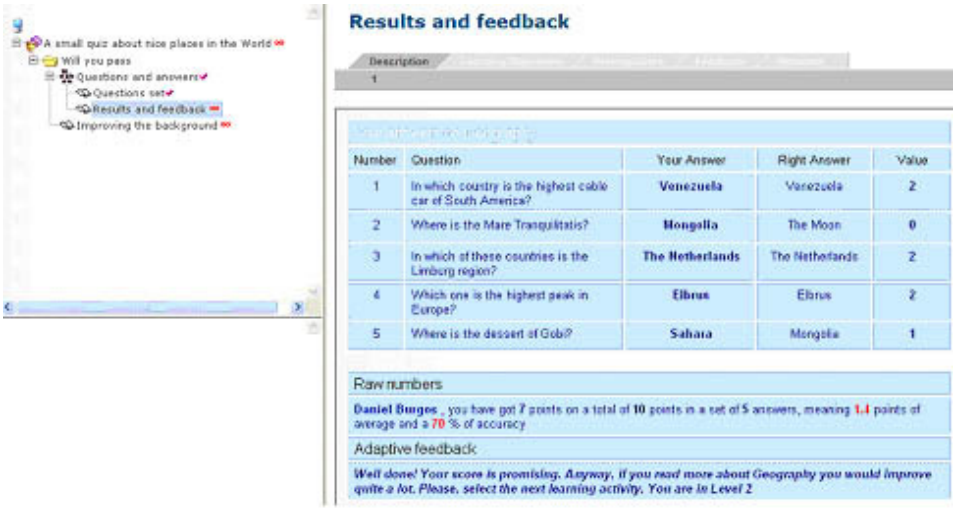


Figure 2. Adaptive Assessment

Before the actual start of the quiz, the name of the user is requested and stored in a property called Name, using the global element <set-property> in an external XML file:

```
Please, enter your name: <set-property
xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="Name" property-
of="self" view="value"/>
```

Afterwards, the questions are raised, from another external XML file that shows the properties with the questions and the possible answers, **Answer1**:

```
  <tr>
    <td height="35">Question 1</td>
    <td>In which country is the highest cable car of South America?</td>
    <td><p><set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0"
ref="Answer1" property-of="self" view="value"/></p></td>
  </tr>
```

Once all the questions are answered, a DIV layer **Answered** shows up with a supporting message:

```
<div class="Answered">
    <p>Perfect. You have entered your answers. Do you want to check your
results? Please, refresh your browser and go ahead</p>
</div>
```

The results are shown now, with <**view-property**>, using a new XML file with all the properties involved in this feedback step. On the one hand, the right answers to the questions, **Value1**:

```
  <tr>
    <td>1</td>
    <td>In which country is the highest cable car of South America? </td>
    <td><p><view-property ref="Answer1" property-of="self"
view="value"/></p></td>
    <td>Venezuela</td>
    <td><p><view-property ref="Value1" property-of="self"
view="value"/></p></td>
  </tr>
```

On the other hand, the interpretation of the results, showing the properties **Name**, **Total**, **Average** and **Accuracy**, coming up after several calculations:

```
<view-property ref="Name" property-of="self" view="value"/>,
        you have got <view-property ref="total" property-of="self"
view="value"/>points
```

```
        on a total of 10 points in a set of 5 answers,

        meaning <view-property ref="average" property-of="self"
view="value"/> points of average and a <view-property ref="accuracy"
property-of="self" view="value"/>% of accuracy
```

Also, the property with the next action to take is shown, **prop-feedback**:

```
<view-property ref="prop-feedback" property-of="self" view="value"/>
```

And the new related Learning Activity is visible in the player (meaning any kind of resource, an HTML file, for instance).

All these steps in the learning flow are possible because of the previous setting in the manifest file, a) setting properties:

```
<locpers-property identifier="Name">

    <datatype datatype="string"/>

</locpers-property>
```

```
<locpers-property identifier="prop-feedback">

    <datatype datatype="string"/>

</locpers-property>
```

```
<locpers-property identifier="Answer1">

    <datatype datatype="string"/>

    <initial-value>Select</initial-value>

    <restriction restriction-type="enumeration">Select</restriction>
    <restriction restriction-type="enumeration">Venezuela</restriction>

    <restriction restriction-type="enumeration">Peru</restriction>

    <restriction restriction-type="enumeration">Ecuador</restriction>

</locpers-property>
```

b) Defining the rule for completion of the learning activity with the set of questions. This rule is the key to provide an adaptive next step to take; as the next activity cannot be shown until this learning activity is closed:

```
<learning-activity identifier="questions">

   <title>Questions set</title>

    <learning-objectives>

    <item identifierref="res-objectives" identifier="I2-objectives">
```

```
            <title>Learning objectives</title>
    </item>
</learning-objectives>
<activity-description>
    <item identifierref="res-questions" identifier="I-questions" />
</activity-description>

<complete-activity>
    <when-property-value-is-set>
            <property-ref ref="all-questions"/>
    <property-value>1</property-value>
   </when-property-value-is-set>
</complete-activity>
</learning-activity>
```

c) Defining rules to check conditions. In the following case, Value1 is assigned with 1 or 2 depending on the content of the property Answer1:

```
<if>
    <is>
            <property-ref ref="Answer1"/>
            <property-value>Venezuela</property-value>
    </is>
</if>
<then>
    <change-property-value>
            <property-ref ref="Value1"/>
            <property-value>2</property-value>
    </change-property-value>
</then>
<else>
    <if>
            <is>
```

```
                    <property-ref ref="Answer1"/>
                    <property-value>Peru</property-value>
            </is>
    </if>
    <then>
            <change-property-value>
                    <property-ref ref="Value1"/>
                    <property-value>1</property-value>
            </change-property-value>
    </then>
</else>
```

d) Defining and hiding DIV classes, like **Answered**, which are shown after all the questions are fulfilled (true=1):

```
<if>
    <is>
            <property-ref ref="all-questions"/>
            <property-value>1</property-value>
    </is>
</if>
<then>
    <show>
            <class class="Answered" />
    </show>
</then>
    <else>
            <hide>
            <class class="Answered" />
    </hide>
    </else>
```

e) Making calculations, a division between **total** and **number-questions** to obtain the **average**:

```
<change-property-value>
    <property-ref ref="average" />
    <property-value>
           <calculate>
                  <divide>
                         <property-ref ref="total" />
                         <property-ref ref="number-questions" />
                  </divide>
           </calculate>
    </property-value>
</change-property-value>
```

And f) defining the key for the adaptive feedback and the next action to take. Depending on the accuracy only one activity is shown, flow1 (from 0% to 49% of accuracy), flow2 (50-75) or flow3 (76-100), together with a feedback message in prop-feedback. These activities are linked to HTML resources:

```
<if>
    <less-than>
           <property-ref ref="accuracy"/>
           <property-value>1</property-value>
    </less-than>
</if>
<then>
    <hide>
           <learning-activity-ref ref="flow1" />
           <learning-activity-ref ref="flow2" />
           <learning-activity-ref ref="flow3" />
</hide>
</then>
<else>
<if>
    <and>
           <greater-than>
```

```
                    <property-ref ref="accuracy"/>
                    <property-value>0</property-value>
            </greater-than>
            <less-than>
                    <property-ref ref="accuracy"/>
                    <property-value>50</property-value>
            </less-than>
    </and>
</if>
<then>
    <change-property-value>
            <property-ref ref="prop-feedback"/>
            <property-value>Insuficient.You are in Level 1</property-value>
    </change-property-value>
    <show>
            <learning-activity-ref ref="flow1" />
    </show>
    <hide>
            <learning-activity-ref ref="flow2" />
            <learning-activity-ref ref="flow3" />
    </hide>
</then>
<else>
<if>
    <and>
            <greater-than>
                    <property-ref ref="accuracy"/>
                    <property-value>49</property-value>
            </greater-than>
            <less-than>
```

```
                    <property-ref ref="accuracy"/>
                    <property-value>76</property-value>
            </less-than>
    </and>
</if>
<then>
    <change-property-value>
            <property-ref ref="prop-feedback"/>
            <property-value>Well done! Level 2</property-value>
    </change-property-value>
    <show>
            <learning-activity-ref ref="flow2" />
    </show>
    <hide>
            <learning-activity-ref ref="flow1" />
            <learning-activity-ref ref="flow3" />
    </hide>
</then>
<else>
    <change-property-value>
            <property-ref ref="prop-feedback"/>
            <property-value>Congratulations! Level 3</property-value>
    </change-property-value>
    <show>
            <learning-activity-ref ref="flow3" />
    </show>
    <hide>
            <learning-activity-ref ref="flow1" />
            <learning-activity-ref ref="flow2" />
    </hide>
```

```
</else>

</else>

</else>
```

In the next examples we will only show the key aspects in every use case, in order to make a neater coding and to focus on the real essential contributions to the topic of adaptive eLearning.

#### 4.2.1.1 Analysis and remarks on this use case

In this section, and the subsequent ones with the same heading, we provide a detailed analysis of what IMS-LD can and cannot model, in its current description model, with regards to adaptation. This analysis concentrates on the weak points and main features of every use case. In the next step of this research (to be presented in **D5.3c Extensions and modifications of learning specifications and LMSs focused on adaptive learning**) these remarks will be addressed to produce a set of recommendations and extensions to improve the pedagogical expressiveness on IMS-LD, focused on adaptation.

1. The definition of properties and the link through several working XML files is too complicated to become useful. Even a simple combobox comes to a struggle that has to be defined by hand, as the current editing level of the available editors is too low or too messy

2. The relation between layers and actions is not straightforward and it has to be done interlacing files, once more

3. The lack of a richer conditional structure makes the editing of the set of rules more complicated on paper than they actually are from a logical point of view

4. In case that a user fails and wants to re-fill the questionnaire, how can he/she do it? Once the questions are answered and the activity is closed (the on completion flag is switched on) the activity cannot be re-initialized and go backwards. As a result, iterations in the activities are not allowed

5. In case the teacher or the learning designer wants to change the questions, the answers, or the content of the next activity to carry out, they cannot do so, as every single resource has to be packed in design and publishing time before the actual running of the instance. Changes on-the-fly are not possible.

### 4.2.2 Use case, adaptation on the learning designer's method: Adaptive Authoring

**File name**: ATOS-AdaptiveAuthoring.zip

**Based on**: Learning Scenario 3. Human Resources Live

Changing things on-the-fly becomes a tricky issue with IMS-LD. Live adaptation becomes crucial when some content, condition or feature must be changed once a UoL has started. If on-the-fly modification does not happen, the whole UoL must be reset, published and started since the beginning, no matter how many users are enrolled and how far they achieved. On the other side, the specification allows it, but the current engines (i.e. CopperCore, netUniversité, .LRN…) do not. Therefore, we have to deal with a limitation of the tools, and not of the specification itself. However, in the current state of the art, we do not have the possibility to change it, as no other engine is available and all existing engines are based on the phases of validation and publication.

Nevertheless, a learning designer is able to perform modifications on the run, as long as they are planned beforehand. We showed it in previous sections. In the following UoL (Figure 3), a whole questionnaire is created empty in design-time and it is adapted by the teacher/learning designer in the run-time, with no further need of re-compilation.

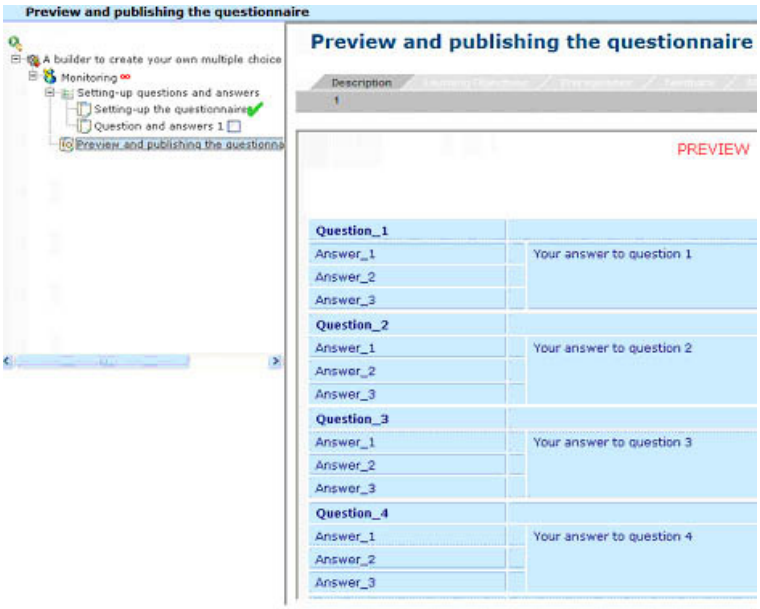


Figure 3. Adaptive Authoring

The main features are:

- setting-up the UoL with full personalisation of questions, answers, right answers, ranges, points earned, welcome and feedback messages , title
- questions and related properties are local (loc-property) and keep the same value for all the users in the same run but personal answers and calculations are private and linked to every participant (locpers-property)
- five questions with three possible answers. A correct answer earns the participant the amount of points defined in the set-up
- only when the participant has answered the five questions (S)he can go ahead and view the results (by refreshing the browser)
- a total sum, a simple average and a percentage of accuracy are calculated
- an adaptive feedback is provided depending on the accuracy (there are four ranges, also defined in the set-up)
- the next activity delivered depends also on the feedback. If the student does not reach the lowest threshold there is no next activity and he/she has to repeat the questionnaire
- there are 2 roles: teacher and participant, and the learning flow swaps between them:
  - First, the teacher sets-up the questionnaire and the participant waits for the opening of the course. The teacher can have a preview of the questionnaire before publishing
  - Second, the teacher publishes the quo and the participant answers the questions. The teacher monitors his/her progress
  - Third, the participant finishes the quo and receive two inputs: an adaptive feedback and a new activity, both based on the results
- the logo and the next activities (Level 1, 2 and 3) can be easily changed in the ZIP file to fit the personal goals of the teacher in an easy way

The main objectives are:

- to work on personalisation, adaptive learning and run-time tracking (monitoring)
- to work on specific features of IMS-LD, like i.e. locpers-properties, loc-properties, data-type real, and initialisation

- to show and hide layers with different content depending on real time results
- to store and calculate values depending on choices
- to set-up key activities to follow the learning process depending on the set-up and on the feedback acquired
- to monitor the progress of the participants in real-time

The key parts in coding are:

Two roles are defined, one staff type (Teacher) and one learner type (Participant):

```
<roles>
    <learner identifier="student">
           <title>Participant</title>
    </learner>
    <staff identifier="teacher">
           <title>Teacher</title>
    </staff>
</roles>
```

Every property can be defined in the setttings.xml file:

```
Title of questionnaire<set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="title" property-of="self" view="value"/>

Points per right answer<set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="points-right" property-of="self" view="value"/>

Message of welcome<set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="welcome" property-of="self" view="value"/>

Level 0 to, inclusive<set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="Level0-to" property-of="self" view="value"/>

Message feedback Level 0<set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="msg-feedback-0" property-of="self" view="value"/>

Level 1 to, inclusive<set-property xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="Level1-to" property-of="self" view="value"/>
```

```
Message feedback Level 1<set-property
xmlns="http://www.imsglobal.org/xsd/IMS-LD_v1p0" ref="msg-feedback-1"
property-of="self" view="value"/>
…
```

For each question, a set of answers are defined using a group of properties called Q1_set, in the case of the first question. Also, the right answer is assigned to Q1_Right, and the related question is assigned to Q1. Every group of question and answers is configured in an independent XML file:

```
<set-property ref="Q1_Right" property-of="self" view="value"/>
<set-property-group ref="Q1_set" property-of="self" view="value"/>
<set-property ref="Q1" property-of="self" view="value"/>
```

There is also an XML file to monitor the current content of the properties, including the state for every participant supported-person:

```
Maximum of points<view-property ref="maximum" property-of="student"
view="value"/>
Total points earned<view-property ref="total" property-of="supported-person"
view="value"/>
Number of questions<view-property ref="number-questions" property-
of="student" view="value"/>
Average per question<view-property ref="average" property-of="supported-
person" view="value"/>
Accuracy<view-property ref="accuracy" property-of="supported-person"
view="value"/>
```

Before the questionnaire is made public the teacher/learning designer can monitor the current state of the questions and the answers, using the setting-ok.xml file. The teacher/learning designer must agree on the publication, switching on the property setting-ok:

```
<set-property ref="setting-ok" property-of="self"/>
```

This monitoring service has to be defined in the manifest file, inside a support activity:

```
<support-activity identifier="SA-setting-ok" isvisible="true">
    <title>Preview and publishing the questionnaire</title>
    <activity-description>
           <item identifier="I-SA-setting-ok" identifierref="res-setting-ok"
isvisible="true" />
    </activity-description>
```

```
    <complete-activity>
            <when-property-value-is-set>
                    <property-ref ref="setting-ok" />
                    <property-value>1</property-value>
            </when-property-value-is-set>
    </complete-activity>
</support-activity>
```

Once that the questionnaire has been published, the teacher-learning designer can monitor the students´ progress:

```
<environment identifier="env-monitoring">
    <title>Monitoring</title>
    <service identifier="service-monitoring">
            <monitor>
              <role-ref ref="student" />
              <title>Monitoring progress of students</title>
              <item identifierref="res-monitoring" />
            </monitor>
    </service>
</environment>
</environments>
```

The most important innovation in this manifest is the definition of the method, with every role-part providing a different action:

Rolepart-1 provides the general set-up

```
<role-part identifier="rolepart-1">
    <title>Teacher</title>
    <role-ref ref="teacher" />
    <activity-structure-ref ref="setting-up" />
</role-part>
```

Rolepart-2 provides the configuration of questions and answers

```
<role-part identifier="rolepart-2">
    <title>Student</title>
```

```
    <role-ref ref="student" />

    <activity-structure-ref ref="questionsandanswers" />

</role-part>
```

Rolepart-3, rolepart-4 and rolepart-5 provide the different post-activities flow1, flow2 and flow3

```
<role-part identifier="rolepart-3">

    <title>Student</title>

    <role-ref ref="student" />

    <learning-activity-ref ref="flow1" />

</role-part>
```

Rolepart-SA-setting-ok provides the teacher with the monitoring service of the configuration and the agreement for publishing the questionnaire

```
<role-part identifier="rolepart-SA-setting-ok">

    <title>Teacher</title>

    <role-ref ref="teacher" />

    <support-activity-ref ref="SA-setting-ok" />

</role-part>
```

Rolepart-monitoring provides the teacher with the service of monitoring the students´ performance

```
<role-part identifier="rolepart-monitoring">

    <title>Teacher</title>

    <role-ref ref="teacher" />

    <support-activity-ref ref="SA-monitoring" />

</role-part>
```

#### 4.2.2.1 Analysis and remarks on this use case

*Note about incremental remarks: from now onwards, the remarks from each use case will be built upon the remarks on the previous case studies, so that we do not revisit the same issues unnecessarily*

6. The monitoring service does not cover any kind of user grouping. Therefore, a user cannot follow the performance of several people at the same time
7. The teacher/learning designer cannot change the amount of questions or answers - it is a fixed number for each entry
8. Questions and answers are not personalised for user, they are the same for everyone
9. The communication between teacher and student is little and indirect. They can only see the values of properties but there is no other communication service between them.

### 4.2.3 Use case, adaptation on the learner's decision: Adaptive Content

**File**: ATOS-AdaptiveContent.zip

**Based on**: Learning Scenario 5. Getting some expertise

In this use case a student can follow a course about Jazz and can choose two different itineraries, thematic and historic, based on his/her preferences (Figure 4). Also, some actions of monitoring can be tackled in the way described previously. This a very complex UoL fed with actual content for a real course, originally developed with EML. Several features on adaptation are shown, like monitoring services, hide/show classes, hide/show learning structures, quizzes, adaptive environments, et cetera.

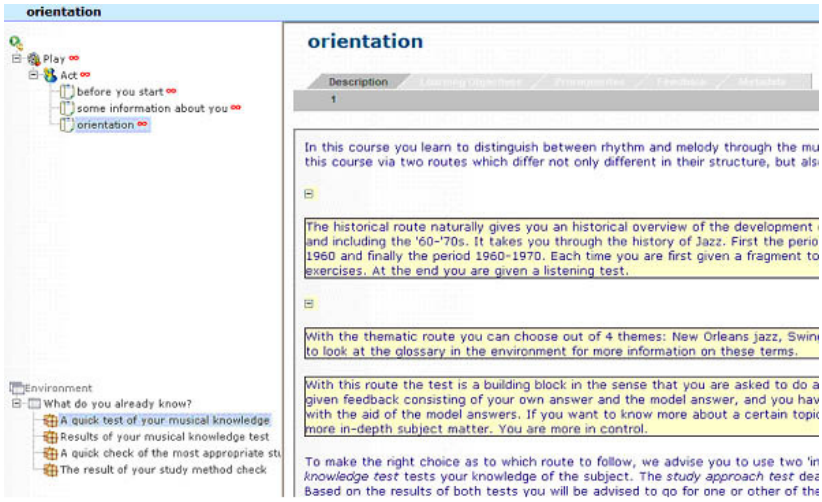


Figure 4. Adaptive Content

Concerning the concept of adaptive learning a property called 'LP-choose-itinerary' is set up to know whether the user has chosen one of the two itineraries. Each of them is described inside their Activity Structure, 'AS-historic' and 'AS-thematic', previously defined in the manifest and out of the scope of this deliverable. The entire process of choosing an itinerary is programmed as a flow of condition, taking one option or the other depending on the value of this property. Both Activity Structures are hidden in the beginning, when value is yet to enter the property:

```
<conditions>

<if>

  <no-value>

    <property-ref ref="LP-choose-itinerary"/>

  </no-value>

</if>

<then>

  <hide>

    <activity-structure-ref ref="AS-thematic"/>

    <activity-structure-ref ref="AS-historic"/>

  </hide>
```

```
</then>
```

The student can pick one of the two options, ‘historic’ and ‘thematic’, available in a combo box. If the user picks the option ‘thematic’, his related structure ‘AS-thematic’ is shown and the non-related structure ‘AS-historic’ is hidden, and the other way around:

```
<if>
  <is>
    <property-ref ref="LP-choose-itinerary"/>
    <property-value>thematic</property-value>
  </is>
</if>
<then>
  <show>
    <activity-structure-ref ref="AS-thematic"/>
  </show>
  <hide>
    <activity-structure-ref ref="AS-historic"/>
  </hide>
</then>
```

These two different structures are also able to have non-identical contents or similar content re-organized in several ways dealing with two complementary or opposite approaches, all managed inside the same manifest coming with the UoL.

The input point to choose the type of itinerary is perfectly defined and it is always fixed and assigned to a different role-part:

```
<role-part identifier="id-1.5.3.8">
    <role-ref ref="student"/>
    <activity-structure-ref ref="As-s-thematisch"/>
</role-part>
<role-part identifier="id-1.5.3.10">
    <role-ref ref="student"/>
    <activity-structure-ref ref="As-s-historisch"/>
</role-part>
```

```
<activity-structure identifier="As-s-historisch" structure-type="sequence">
```

```
    <title>historical route</title>
    <information>
           <item identifierref="res-1.5.2.1.1.1"/>
    </information>
    <environment-ref ref="env-1.5.2.1.1.1"/>
    <learning-structure-ref ref="la-bebop"/>
    <learning-activity-ref ref="la-free-jazz"/>
    <learning-activity-ref ref="la-change-itinerary-question"/>
    <learning-activity-ref ref="la-swing"/>
    <learning-activity-ref ref="la-new-orleans"/>
</activity-structure>
```

```
<activity-structure identifier="As-s-thematisch" structure-type="selection"
number-to-select="5">
    <title>Thematic route</title>
    <information>
           <item identifierref="res-1.5.1.1.1.1"/>
    </information>
    <environment-ref ref="env-1.5.1.1.1.1"/>
    <learning-structure-ref ref="la-bebop"/>
    <learning-activity-ref ref="la-free-jazz"/>
    <learning-activity-ref ref="la-change-itinerary-question"/>
    <learning-activity-ref ref="la-swing"/>
    <learning-activity-ref ref="la-new-orleans"/>
</activity-structure>
```

In this last activity structure type **selection** the user needs to complete 2 activities (user-choice) before he/she gets the question that allows for changing the itinerary, as there is no sequence where to launch the question from, but a specific amount of activities carried out (2 activities). Therefore, we need to define a property for each learning activity in the activity structure that sums 1 when it is completed and remains 0 when it is not. For instance, for the learning activity free-jazz:

```
<locpers-property identifier="prop-free-jazz">
    <title>free jazz thematically complete</title>
```

```
    <datatype datatype="integer"/>
    <initial-value>0</initial-value>
</locpers-property>
```

```
<learning-activity identifier="la-free-jazz" isvisible="true">
    <title>free jazz</title>
    <activity-description>
        <item identifierref="res-free-jazz">
            <title>what is Free Jazz</title>
        </item>
    </activity-description>
    <complete-activity>
        <user-choice/>
    </complete-activity>
    <on-completion>
        <change-property-value>
            <property-ref ref="prop-free-jazz"/>
            <property-value>1</property-value>
        </change-property-value>
    </on-completion>
</learning-activity>
```

Later on, we define a condition to permanently check the state of these properties, to sum up their values, and to show the expected question as long as the final result is greater than 1, so it is actually 2 or greater - this represents the condition to present the question itself. As the learning activities are the same in both itineraries we also have to check the value of the property prop-itinerary to know whether the user is following the right itinerary to run this condition (thematic):

```
<conditions>
    <if>
        <and>
        <is>
            <property-ref ref="prop-itinerary"/>
            <property-value>thematic</property-value>
```

```
            </is>
            <greater-than>
                    <sum>
                            <property-ref ref="prop-bebop"/>
                            <sum>
                                    <property-ref ref="prop-new-orleans"/>
                                    <sum>
                                            <property-ref ref="prop-swing"/>
                                            <property-ref ref="prop-free-jazz"/>
                                    </sum>
                            </sum>
                    </sum>
                    <property-value>1</property-value>
            </greater-than>
            </and>
    </if>
    <then>
            <show>
                <learning-activity-ref ref="la-change-itinerary-question"/>
            </show>
    </then>
    <else>
            <hide>
                <learning-activity-ref ref="la-change-itinerary-question"/>
            </hide>
    </else>
</conditions>
```

#### 4.2.3.1 Analysis and remarks on this use case:

10. There is a lack of flexibility on the input point to raise the question and possibly change the itineraries. In the type sequence the learning activity with the question always appears at the same place. In the type selection, the question is always asked after 2 completed learning activities. What if the learning

designer/teacher wants to change the method and shift this input point? From 2 to 3 completed LA´s or from the third in a row to the forth? – for the moment the ability to do so is limited

11. There is no possibility to run the UoL which represents the use case (the whole UoL or a part, such a Learning Activity) two times within the same instance. Once that a Learning Activity is closed, the user can read it again but the associated learning flow cannot be executed. For instance, after the question to change the itinerary is made in the historisch-route, there is no way to go back

12. This use case shows a real course. There is no flexibility to change the content either. When the teacher/learning designer wants to keep the same method and the same structure, but he/she only wants to change one single HTML page with some content, the UoL has to be validated and published again, the learner and the teacher have to be enrolled and the learning process starts from the very beginning

13. There is no option to handle absolute time to start the course and/or a specific activity. Only relative time to the precise time can be used when the instance is created out of the UoL.

### 4.2.4 Use case, adaptation on the teacher's decision: Adaptive Mentoring

**File**: ATOS-AdaptiveMentoring.zip

**Based on**: Learning scenario 1. Making a project proposal

In this use case the teacher monitors the whole process of assessment, from the first submission by the learner to the final grade by the teacher. It follows a discussion of two steps with the student who sent the assignment (Figure 5).

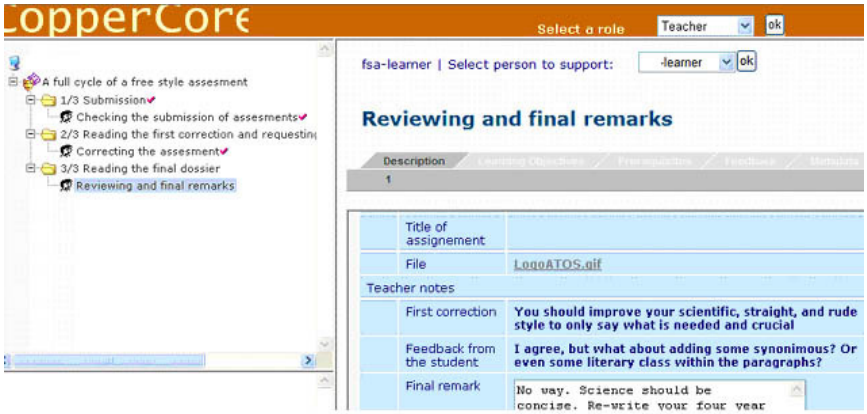


Figure 5. Adaptive Mentoring

The learning flow is as follows:

– the student submits his personal info and his assessment to the tutor

– the teacher checks the submission of all the students and closes this activity

– the teacher grades the assessment and make his own remarks

– the student reads the first remarks and can provide some feedback (critic, complain, remark...). The teacher closes this activity

– the teacher grades (second round) the assessment, taking into account student's remarks, and assigns a qualification and a numerical mark. The teacher closes this activity.

– the student reads his dossier and can also have a look at the marks and qualifications of others

#### 4.2.4.1 Analysis and remarks on this use case:

14. There is no possibility to make a connection to an already existing Database (for instance, to make a query or to import already enrolled students or teachers). The data type of connection is not supported. Therefore, each enrolment has to be done by hand or by running a specific tool for that.

15. Furthermore, any connection with the external world is impossible. For instance, a real-time effective communication between a LMS and an IMS-LD UoL is not possible so far, so, in fact, they cannot benefit each other from mutual services and resources. There is no dispatcher allowing such connection.

16. A file uploaded from the hard disk of the computer of a user is stored in a file-type property inside the internal database of the engine (CopperCore in this case). There is no option to change the default configuration for storing or retrieving resources. There is no facility to manage such uploads either. Although this is an issue concerning tools, the core documents of IMS-LD do not provide with this information and/or facility either.

17. There is a fixed number of iterations in the reviewing process. The teacher/learning designer can make this number smaller but he/she cannot make it bigger. What happens if the discussion needs one additional round?

18. There is no chance to perform a dynamic selection of users in order to create groups. The teacher can monitor users one by one and can provide some feedback one by one. We could set-up a property to answer by groups, but these groups should be established before the actual start. However, if the teacher wants to make a dynamic creation of a group of students depending on their answers, this is not possible so far.

# 5 Application case: Industry setting (Foundation Course on IMS-LD)

**File name**: ATOS-FoundationCourseOnIMSLD.zip

**Based on**: Learning Scenario 1. Writing a project proposal, and Learning Scenario 2. A new skill

This application case shows a UoL on a certain topic (the IMS Learning Design specification) required to follow the subject on “eLearning and Accessible Standards” at the ATOS University, a centralised training centre for the worldwide corporation. This subject is followed online by two groups of up to 50 participants to be enrolled in a professional training carried out with the collaboration of the Spanish Initiative for Technology Enhanced Learning, TEL Spain (www.telspain.es).

These two groups consist of learners with assorted background, specific knowledge, personal functional diversity, and a common goal on acquiring some expertise on eLearning and Accessibility standards. Their support requirements will range from no support at all, through visual and audio support, to personal mentoring. Furthermore, two groups are scheduled due to tutoring purposes, since up to 50 learners per tutor make a feasible student-teacher ratio to achieve a high performance of the learning process.

Previously to the final release, this UoL is tested by a selected group of experts focused on eLearning and/or Accessibility, in order to provide some useful feedback for further refinement. In doing so, the prototype will be evaluated in a two-phase process: expert evaluation and end-user evaluation.

With regards to the subject of the UoL, the learner will:

- Learn basic concepts about IMS Learning Design
- Read introductory information about the specification
- Play running examples of UoLs
- Become familiar with other related specifications focused on eLearning and Accessibility issues
- The expected result is to obtain a general coverage of IMS Learning Design and to be able to run and understand at least one of the provided examples.

The main features of this application case are:

- Followed by 1-50 students per group
- There is a pre-test about previous knowledge
- There is a pre-quo about request for assistance
- Based on pre-test+pre-quo, the course will be delivered to a beginner or an advanced learner, and with or without audio+visual assistance (4 possible settings):
  - Beginners/Advanced, With/Without support
- With every setting, a specific pedagogic guidance plus a set of learning resources will be provided. This pedagogic guidance will support the teacher's role for a group of students in the same setting (group guidance)
- A final summative evaluation will assess the knowledge acquired

**Focus**: personalised learning itinerary, learning strategy, self-evaluation, user performance

**Roles**: learner, set of rules.

**Learning Categories**: Understanding, Remembering, Evaluating

**Learning Strategies**: Meta-cognitive, Elaboration, Monitoring and Regulating, Organizational, Rehearsal

**Learning flow:**

The learner of this UoL will go through the following learning itinerary:

1. After a brief presentation of the UoL and the process, the user is requested to personalise the feedback

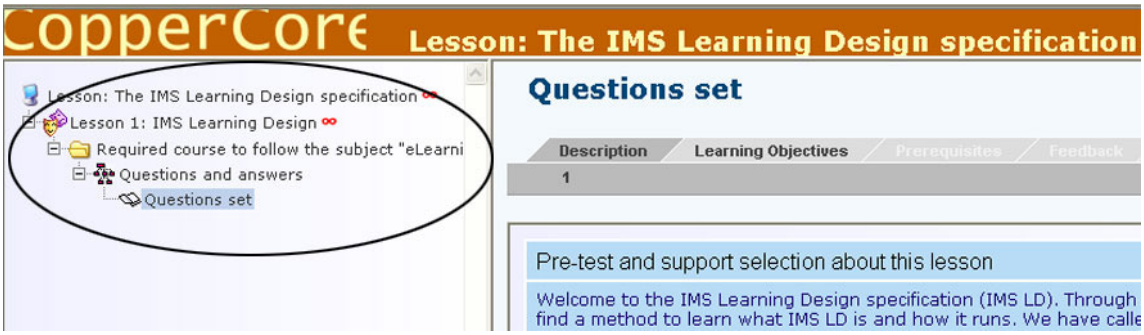


Figure 6. Foundation course on IMS-LD. Pre-test

2. Four questions with three possible answers. Depending on the answer, a score is provided (2 points) with a maximum score of 8 for the full test. An additional question is made to request or decline additional learning support

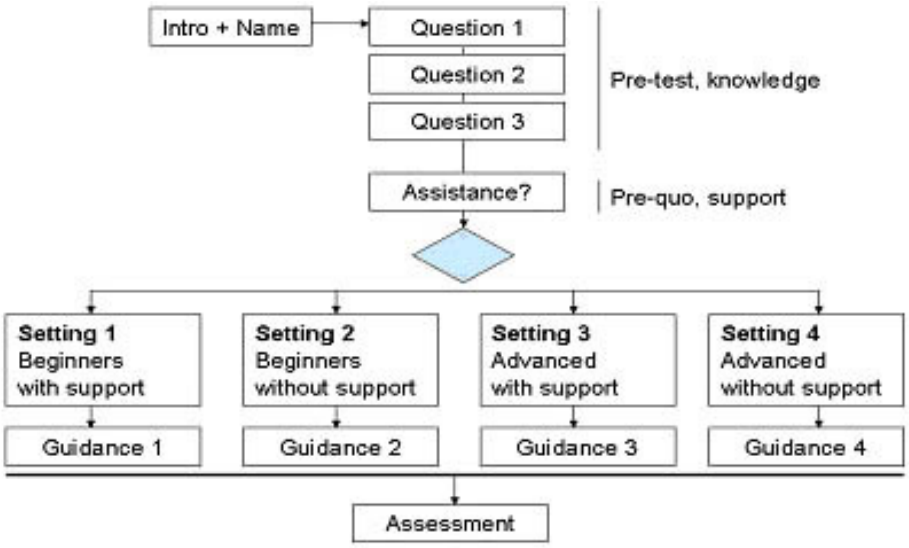


Figure 7. Foundation course on IMS-LD. Learning flow

3. Only when the learner has answered the five questions (s)he can go ahead and view the results
4. A total, simple average and a percentage of accuracy are calculated and shown
5. An analysis of the results is provided depending on the average and the accuracy

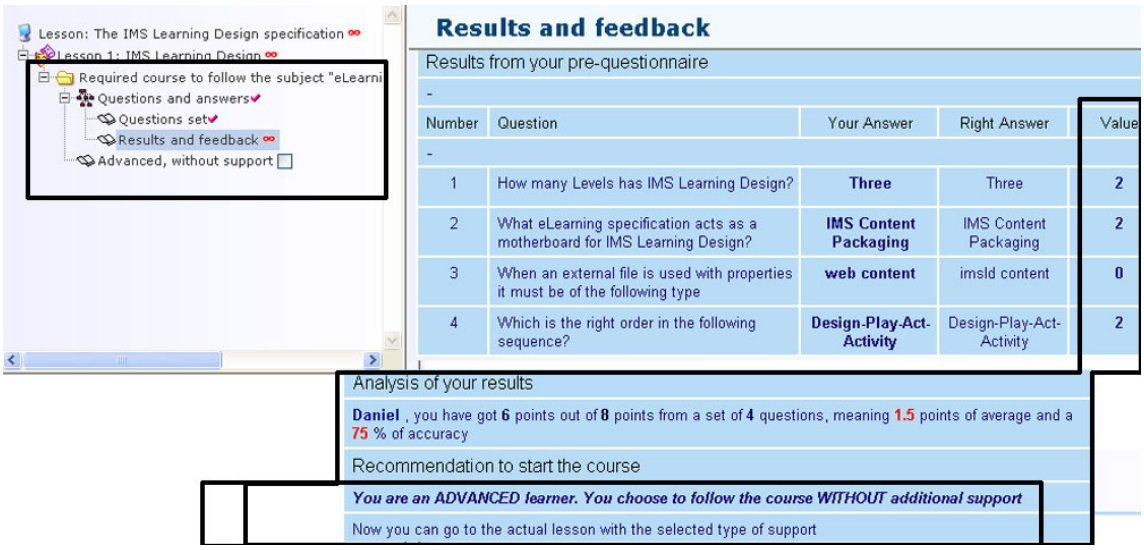


Figure 8. Numerical analysis of results and adapted learning flow

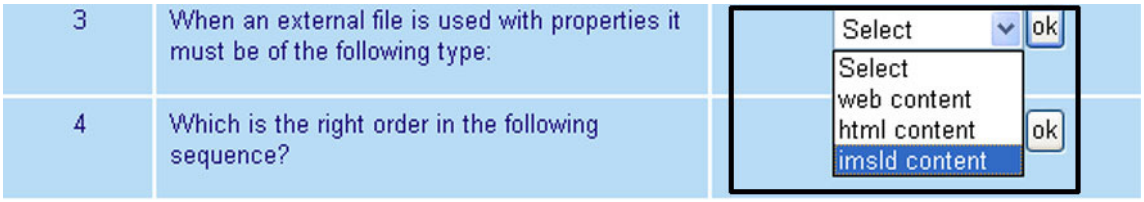


Figure 9. Selection of answers from the combobox to assess previous knowledge

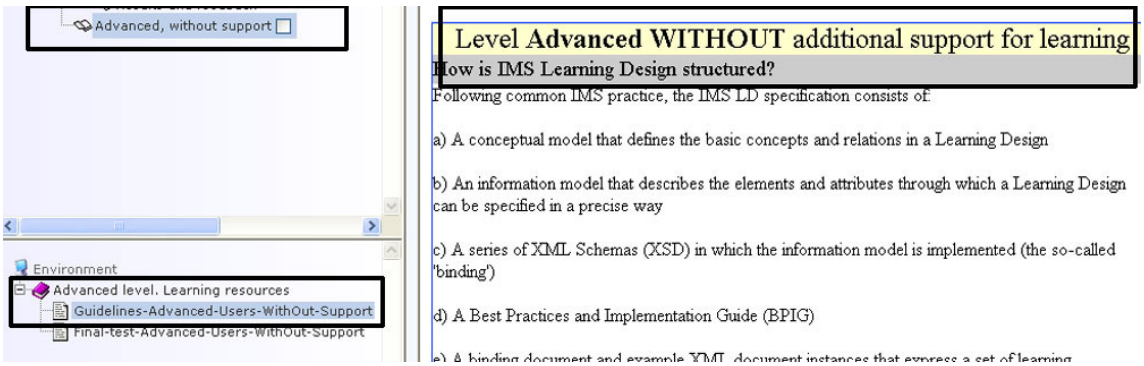


Figure 10. Activity and type of support adapted to knowledge and personal choice

6. The next activity delivered depends on the accuracy and the type of support

7. Every itinerary provides:

- A specific content, based on previous knowledge and the target group addressed (beginners/advanced)
- The type of learning support selected (with/without)
- A specific educational external guidance

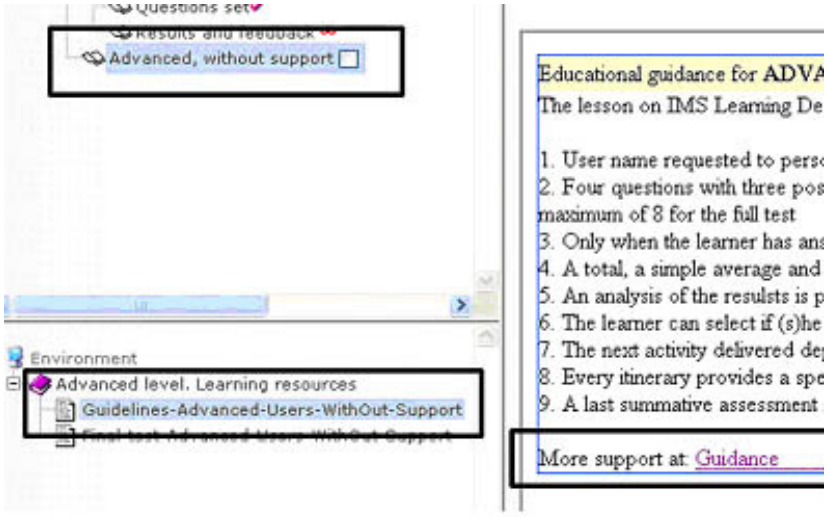


Figure 11. Educational guidance and link to external support

8. A final summative assessment is carried out, corresponding to an open essay to be sent to the tutor

**Technical objectives:**

In addition to the educational and modelling objectives, the technical challenges are:

- To show and hide layers with different content
- To set-up and manage properties to handle the answers, inside the manifest.xml file
- To use ´view-property´ and ´set-property´ in external XHTML files together with information layers
- To store values depending on choices and make calculations with them
- To adapt the learning process depending on the feedback acquired. This feedback depends on the learner's pre-knowledge and on his/her personal decision about the type of support.

# 6 Learning Process Components for re-use of IMS-LD resources

Out of our research on IMS-LD, the analysis and remarks from the Learning Scenarios and use cases afore detailed, we design, produce and deliver specific templates ready to be used. Every guideline requires a technical solution expressed with IMS-LD. But not every single guideline needs an isolated solution. The use of applied, specific templates (in form of chunks or code snippets) and the re-purpose of UoLs are one of the core objectives of any (eLearning) standard: re-use. This potential re-use envisages Grapple CAM, and it will be showed in D5.3c (M30). We call them Learning Process Components. Furthermore, we focus our solution on both resources: a) modelling of chunks that could be used in any UoL, regardless of the described Learning Scenarios, but always matching their needs; and b) modelling of templates and UoLs, out of generic Learning Scenarios, that could be re-purposed by every practitioner as needed.

Out of the research carried out in previous sections, we show the following list of stand-alone templates that could be used to express adaptive features with IMS-LD (table 1). There is a need for finding, listing and coding these code-chunks since they will become the basic units for modelling technical learning solutions with IMS-LD. These are available on the Grapple website too [http://www.grapple-projec.org]. A number of these components are still under research, since IMS-LD does not originally allow for them. So far, we have implemented a basic set with 16 templates; a possible implementation and further use of the other 9, to count up to the 25 in the list, is under analysis and development. Further research on this issue will be presented in deliverable **D5.3c Extensions and modifications of learning specifications and LMSs focused on adaptive learning.**

| ID | Component | Example of use… |
|---|---|---|
| PC-1 | Fork 2 | Dilemma, personalised learning flow |
| PC-2 | Fork 3-n | Multiple choice, multiple decision, personalised learning flow |
| PC-3 | Query to 1 | Direct question to 1 user |
| PC-4 | Query to n | Open question to a group of users |
| PC-5 | Debate 2 | Peer discussion |
| PC-6 | Debate n | Group discussion |
| PC-7 | Upload resource file | Live, one file to the UoL |
| PC-8 | Upload resource link | Live, one link to the UoL |
| PC-9 | Log-in | To the UoL, to 1 activity |
| PC-10 | Log-out | From the UoL, from 1 activity |
| PC-11 | Open | Open activity, switch on, visible on |
| PC-12 | Close | Close activity, switch off, visible off |
| PC-13 | Closed assessment with auto feedback | Quiz with check boxes or multiple choice selection |
| PC-14 | Open assessment with open feedback | Form with open fields |
| PC-15 | Monitor 1 | 1 tutor monitors 1 student |
| PC-16 | Monitor n | 1 tutor monitors 1 group of learners |
| PC-17 | Content editing by 1 | Live, 1 learner makes content, 1 tutor makes content |

| | | |
|---|---|---|
| PC-18 | Content editing by n | Live, 1 group of users makes content |
| PC-19 | Auto user grouping | Groups are made automatically |
| PC-20 | Direct user grouping | Direct selection of group members |
| PC-21 | Service linking | Connect to a service (blog, wiki, chat…) |
| PC-22 | External software | Link to and bi-directional communication flow with external applications (i.e., database…) |
| PC-23 | Update personal records | User's behaviour recorded, user's performance recorded |
| PC-24 | Iteration | 1 user makes 1 action several times until a condition is true |
| PC-25 | Rules definition | Live, defines the decision engine of the system taking on board every role involved (tutor, learner…) |

Table 1: Learning Process Components in IMS-LD

# 7 Conclusions and further research

As a core part of this research, we designed and modelled four use cases and one application case focused on industry setting, which implement UoLs where adaptive learning processes are expressed. These use cases are based on previous research on Learning Scenarios and adaptation with IMS Learning Design (D5.3a). They provide re-usable resources to be personalised in specific context by third parties. In addition, we provide a set of ready-to-use templates to be integrated in new UoLs. We use all of them as a base to find restrictions, drawbacks and elements to improve within the specification. These resources show how far IMS-LD can go on adaptation, when different inputs and roles are involved. We also make links to the integration of UoLs, when needed. Out of the modelling and development of those UoLs we perform an analysis on which features, elements and components are missing or could be modified in order to achieve a more adaptive- and expressive-oriented general definition, with the ultimate aim of improving the specification and bringing it closer to actual needs on eLearning.

Following, we summarize our principal findings, mainly highlighting the limitations we have found:

1. The definition of properties and the link through several working XML files is too complicated to become useful. Even a simple combobox comes to a struggle that it has to be defined by hand, as the current editing level of the available editors is too low or cumbersome
2. The relation between layers and actions is not straightforward and it has to be done interlacing files, once more
3. The lack of a richer conditional structure makes the editing of the set of rules more complicated on paper than they actually are from a logical point of view
4. In case that a user fails and wants to re-fill a questionnaire, he/she finds that Iterations in the activities are not allowed. Once the questions are answered and the activity is closed, the activity cannot be re-initialized and/or go backwards
5. In case that the teacher or the learning designer wants to change the questions, the answers, or the content of the next activity to be carried out, they find that changes on-the-fly are not possible. Every single resource has to be packed in design and publishing time before the actual running of the instance.
6. The monitoring service doesn't cover any kind of user grouping. Therefore, a user (either a teacher or a learner) cannot follow the performance of several other users at the same time
7. The teacher/learning designer cannot change the number of questions or answers. It is fixed for each entry

8. Questions and answers are not personalised for user, rather, they are identical for all users with the same role
9. The communication between teacher and student is little and indirect. They can view the values of properties but there is no other communication service between them
10. There is a lack of flexibility on the input point of changing the itineraries. In the type sequence the learning activity with the question appears always at the same place. In the type selection, the question is always presented after 2 completed learning activities. In case the learning designer/teacher wishes to shift this input point, they cannot do so
11. There is no option to run the UoL (the whole UoL or a part, such a Learning Activity) twice within the same instance. Once a Learning Activity is closed, the user can read it again but the associated learning flow cannot be executed. For instance, after the question to change the itinerary is made in the historic-route, there is no way to go back
12. There is no flexibility to change the content. When the teacher/learning designer wants to keep the same method and the same structure, but he/she wants to change one single HTML page with some content, the UoL has to be validated and published again. In this case, the learner and the teacher would have to be enrolled and the learning process starts from the very beginning
13. There is no possibility to handle absolute time to start the course and/or a specific activity. Only relative time to the precise time when the instance is created out of the UoL
14. There is no chance to make a connection to an already existing database (for instance, to make a query or to import already enrolled students or teachers). The data type of connection is not supported. Therefore, every enrolment has to be done by hand or running a specific tool for that
15. Furthermore, any connection with the external world is impossible (as we addressed in the previous chapter on Interoperability). For instance, a real-time effective communication between an LMS and an IMS-LD UoL is not possible so far, so that in fact they cannot benefit each other from mutual services and resources. There is no dispatcher allowing such connection
16. A file uploaded from the hard disk of the computer of a user is stored in a file-type property inside the internal database of the engine (CopperCore in this case). There is no possibility to change the default configuration for storing or retrieving resources. There is no facility to manage such uploads either. Although this is an issue concerning tools, the core documents of IMS-LD do not provide this information and/or facility either
17. There is a fixed number of iterations in the reviewing process. The teacher/learning designer can make this number smaller but he/she cannot make it bigger. This limits the ability to hold additional discussions when necessary
18. Performing a dynamic selection of users in order to create groups is not possible. The teacher can monitor each user, and provide him/her with some feedback on a personal basis. We could set-up a property to answer by groups, but these groups should be established before the actual start. However, if the teacher wants to make a dynamic creation of a group of students depending on their answers, this is not possible so far
19. The connection with an external database, aside from the internal database of the engine (CopperCore 3.0) is not possible so far and it is not in the scope of the specification
20. IMS-LD and the database of the engine do not allow for any kind of query from recorded information
21. IMS-LD does not allow for recording the behaviour of the user, so that in fact no measures (i.e., Total Time Needed, Time Before First Move) can be restored or retrieved
22. Users cannot be dynamically enrolled within the UoL, once it has started, and they are managed by an external tool
23. IMS-LD does not allow saving information into external files or retrieving information from any external source

We conclude that when looking for an example of adaptation based on the user's behaviour we found that this cannot be developed using the IMS-LD specification. The current state of tooling does not support it either. We also realised that, even when the executable module is developed with other technologies (Macromedia Flash and PHP, for instance), it cannot be integrated with IMS-LD in any way. Therefore, we also identified an interoperability problem. Although IMS-LD is not developed with the intention of supporting

such interactivity with users, it could allow for a valid integration with external resources using a layer of communication/dispatcher.

In the next deliverable, D5.3c, we will present the results of our research, which will provide a rich and structured set of recommendations, modifications and extensions to improve the expressiveness of IMS Learning Design on adaptive learning processes.

# References

1. Burgos, D., Tattersall, C., & Koper, E. J. R. (2006). Representing adaptive and adaptable UoLs. How to model personalised eLearning in IMS Learning Design. In B. Fernández Manjon, J. M. Sanchez Perez, J. A. Gómez Pulido, M. A. Vega Rodriguez & J. Bravo (Eds.), Computers and Education: E-learning - from theory to practice. Germany: Kluwer.
2. Burgos, D., Tattersall, C., & Koper, R. (2007). How to represent Adaptation in eLearning with IMS Learning Design. Interactive Learning Environments, 15(2), 161-170.
3. IMS (2001) Content Packaging. Boston: USA. Available at www.imsglobal.org. Retrieved on August 15th, 2005
4. IMS (2003) Learning Design. Boston: USA. Available at www.imsglobal.org. Retrieved on July 30th, 2005
5. IMS (2003a) Simple Sequencing. Boston: USA. Available at www.imsglobal.org. Retrieved on July 30th, 2005
6. IMS (2003b) Question and Test Interoperability. Boston: USA. Available at www.imsglobal.org. Retrieved on July 29th, 2005