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TENCompetence

Building the European Network for Lifelong Competence Development

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M6.1 Templates of the pedagogical models to be used in authoring environment; model that combines classical and new forms of assessment

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# Project Milestone Report

**Milestone M6.1 – Templates of the pedagogical models to be used in authoring environment; model that combines classical and new forms of assessment**

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<thead>
<tr>
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<th>WP6 Learning Activities &amp; Units of Learning</th>
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This report provides (a) an overview of the requirements and the architectural design of a 3rd generation IMS LD Authoring Tool that will support learning designers and educational practitioners through the entire lifecycle of expressing, representing and sharing Units of Learning for lifelong competence development, (b) a specification for defining Assessment Processes, as an internal part of the design process of a UoL and (c) an analysis of the requirements and possible approaches for the definition of a Connector Protocol for IMS LD Run-time engines to connect to external communication and collaboration services.

**Keywords List**
- IMS Learning Design Authoring
- Assessment Model
- Run-time IMS LD Services
- Pedagogical Templates
- Units of Learning

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<td>OUNL</td>
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</tr>
</tbody>
</table>
# TABLE OF CONTENTS

## A. INTRODUCTION TO WP6 (LEARNING ACTIVITIES & UNITS OF LEARNING)

A.1 WP6 Scope and Objectives ................................................................. 10
A.2 WP6 Contributions to TenCompetence Domain Model .................. 13
A.3 WP6 Internal Structure .................................................................. 14

## B. IMS LEARNING DESIGN AUTHORING

B.1 Introduction to IMS Learning Design Authoring for Lifelong Competence Development ................................................................. 18
   B.1.1 Lifelong learning and competence development ......................... 18
   B.1.2 What is a pedagogical model for lifelong competence development? ... 19
   B.1.3 Supporting educational practitioners in designing for lifelong competence development ................................................................. 20

B.2 Designing Learning Activities for Lifelong Competence Development ................................................................. 22
   B.2.1 Competence Development Lifecycle and IMS LD Basic Authoring Steps ......................................................................................... 22
   B.2.2 Basic Steps for Expressing an Educational Scenario and/or Unit of Learning for Lifelong Competence Development ......................... 24

B.3 Exemplified Pedagogical Scenarios (Templates) .............................. 37
   B.3.1 Problem-based Learning ............................................................... 37
   B.3.2 Project-based Learning ................................................................. 49

B.4 Use Cases of IMS Learning Design Authoring ................................. 59
   B.4.1 Expressing an Educational Scenario .............................................. 59
   B.4.2 Representing an Educational Scenario in a Machine Interoperable Format ......................................................................................... 63
   B.4.3 Populating an Educational Scenario with Educational Resources ...... 64
   B.4.4 Sharing an Educational Scenario and/or Unit of Learning within a Community of Educational Practice ................................................. 67
D. IMS LD RUN-TIME

D.1 Introduction

D.1.1 Will the real service please stand up?

D.2 Design Considerations

D.2.1 Related Work

D.2.2 Providing support for services within TenCompetence

D.2.3 The way forward

D.3 Integration of Existing Runtime Tools

D.3.1 Relevant work for the Ten Competence Project

D.3.2 Introduction

D.3.3 Background

D.3.4 Design Considerations

D.3.5 Planning and Design

D.3.6 Implementation

D.3.7 Testing the prototype with a real example

D.3.8 Summary of Integration work

D.3.9 Future possibilities of SCORM Integration

D.4 Use Cases

D.5 Requirements

D.5.1 Technical Requirements

D.5.2 Functional Requirements

D.5.3 Non-functional Requirements

D.6 Approaches to the Solution

D.7 Proposed Solution

D.8 Exemplified pedagogical scenarios

D.8.1 Scenario One: Astronomy

D.8.2 Scenario Two: Guitar Playing for Beginners

D.9 IMS LD Run-time Conclusions and Future Work
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TenCompetence Domain Model v1.0</td>
</tr>
<tr>
<td>2</td>
<td>TenCompetence Domain Model items related to WP6 activities</td>
</tr>
<tr>
<td>3</td>
<td>Competence Development Lifecycle at different levels</td>
</tr>
<tr>
<td>4</td>
<td>Implementing the Competence Development Lifecycle in TenCompetence (retrieved from TenCompetence Domain Model)</td>
</tr>
<tr>
<td>5</td>
<td>Exemplary Learning Flow for Problem-based Learning</td>
</tr>
<tr>
<td>6</td>
<td>Brainstorming Complex Activity in Exemplary Learning Flow for Problem-based Learning</td>
</tr>
<tr>
<td>7</td>
<td>Research Complex Activity in Exemplary Learning Flow for Problem-based Learning</td>
</tr>
<tr>
<td>8</td>
<td>SMART blueprint scaffold (adopted from Barron et. al.)</td>
</tr>
<tr>
<td>9</td>
<td>Exemplary Learning Flow for Project-based Learning</td>
</tr>
<tr>
<td>10</td>
<td>Overview of IMS LD Authoring Tools</td>
</tr>
<tr>
<td>11</td>
<td>The TenC IMS LD Authoring Tool Architecture</td>
</tr>
<tr>
<td>12</td>
<td>Cycle of learner action and goals in competence development</td>
</tr>
<tr>
<td>13</td>
<td>Function and forms of assessment in the cycle of competence development</td>
</tr>
<tr>
<td>14</td>
<td>Assessment functions to be supported in the different stages of competence development and examples of e-support</td>
</tr>
<tr>
<td>15</td>
<td>A process model for peer assessment</td>
</tr>
<tr>
<td>16</td>
<td>A screenshot of the execution of the peer assessment example</td>
</tr>
<tr>
<td>17</td>
<td>Process model of the 360 degree feedback example</td>
</tr>
<tr>
<td>18</td>
<td>The stages in the assessment process</td>
</tr>
<tr>
<td>19</td>
<td>Assessment design: class diagram of the concepts and their relations</td>
</tr>
<tr>
<td>20</td>
<td>Item construction: class diagram of the concepts and their relations</td>
</tr>
<tr>
<td>21</td>
<td>Assessment construction: class diagram of the concepts and their relations</td>
</tr>
<tr>
<td>22</td>
<td>Assessment run: class diagram of the concepts and their relations</td>
</tr>
<tr>
<td>23</td>
<td>Response processing: class diagram of the concepts and their relations</td>
</tr>
<tr>
<td>24</td>
<td>Decision making: class diagram of the concepts and their relations</td>
</tr>
<tr>
<td>25</td>
<td>Assessment plan, assessment scenario and unit of assessment modelled in more depth</td>
</tr>
<tr>
<td>26</td>
<td>The TenCompetence Assessment Model</td>
</tr>
<tr>
<td>27</td>
<td>Assessment Design Stage 1</td>
</tr>
</tbody>
</table>
Figure 28: Assessment Design Stage 2 .................................................................147
Figure 29: Assessment Design Stage 3 .................................................................148
Figure 30: Assessment Design Stage 4 and 5 .........................................................150
Figure 31: IMS LD Level A and Level B Services ..................................................170
Figure 32: The CooperCore Player ...............................................................183
Figure 33: The Reload SCORM Player Desktop Client application (java swing based) ..........184
Figure 34: Reload SCORM Player Web Application running within a browser (java, jsp and struts based) ..............................................................................................................185
Figure 35: How the SCORM 1.2 Engine fits into the existing framework ..........188
Figure 36: How the traditional SCO is loaded into a Frameset ......................188
Figure 37: The structure of the SCORM runtime software ....................190
Figure 38: The SCO as seen within a browser .................................................193
Figure 39: CooperCore Player: Initiating a Unit of Learning ......................195
Figure 40: The pieces of the puzzle concerned with SCO communication ......202
Figure 41: The method of the UOL showing the acts ....................................204
Figure 42: The Properties Pane .................................................................205
Figure 43: The Condition Editor .................................................................205
Figure 44: Changing the resource type to adl_sco_v1p2 ..................................206
Figure 45: The Learner starts the Unit of Learning ........................................207
Figure 46: The Learner starts the SCO test .......................................................208
Figure 47: The Learner completes the SCO test and posts results .................208
Figure 48: The Learner has answered some question incorrectly ................209
Figure 49: The Learner still has not answered all questions correctly ............210
Figure 50: The Learner has answered all questions correctly .........................210
Figure 51: Activity diagram for “Astronomy” Scenario ................................229
Figure 52: Activity diagram for “Guitar Playing for Beginners” Scenario .........231
LIST OF TABLES

Table 1: Mapping of Competence Development Lifecycle with TenCompetence Domain Model items ................................................................................................................23
Table 2: Mapping of TenC Competence Components with Cheetham and Chivers Competence Core Components...................................................................................25
Table 3: Mapping of TenC Competence Components with Bloom’s Learning Objective Domains ......................................................................................................................26
Table 4: Analysis of Learning Objectives Cognitive Domain (Bloom et. al., 1956).............26
Table 5: Analysis of Learning Objectives Affective Domain (Kathwohl et. al., 1964).........27
Table 6: Examples of Taxonomies for Learning Objectives Psychomotor Domain..............27
Table 7: Taxonomy of Learning Objectives per Competence Component used in TenCompetence .................................................................................................................29
Table 8: Graphical Modeling Elements for describing the Flow of Activities .......................31
Table 9: Taxonomy of Learning Activities used in TenCompetence ..................................36
Table 10: Problem-based Learning Objectives per Competence Component .....................38
Table 11: Project-based Learning Objectives per Competence Component .......................50
Table 12: IMS LD Authoring Use Case Coverage Matrix .....................................................72
Table 13: Mapping of TenC IMS LDAT components/modules to IMS LD Authoring Process Phases .............................................................................................................74
A. Introduction to WP6 (Learning Activities & Units of Learning)

A.1 WP6 Scope and Objectives

Learning activities are the designed or performed activities of a person that are directed at the attainment of a (explicit or implicit) learning objective. Designed learning activities are called 'units of learning' (UoLs), such as courses, workshops, lessons, etc. A unit of learning adds a 'learning design' to the knowledge resources; they add pedagogical aids like study tasks, tutoring, mentoring, monitoring communication services, feedback, formative and summative assessments [TenC Proposal, pp. 46-47].

According to the TenCompetence Description of Work, the main objectives of this Work Package are the following [TenC DoW, pp. 23, 62]:

- Research and develop new and existent flexible pedagogical models & learning activity models facilitating and integrating individual learning, collaborative learning, organisational learning and knowledge management, usable for a variety of settings and users (individuals, groups and organisations).

- Select and adapt existing tools, and develop missing tools, for the creation, storage, search, retrieval, reuse, sharing and quality rating of learning activities & units of learning to create the components in the second architectural layer that can be integrated as services at the third layer within the Integrated TenCompetence System.

- Develop a formal specification model and supporting tools that combines new assessment types and the ones included in the IMS QTI (providing input for standards development).

- Develop a formal specification to connect communication & collaboration services to LD runtime engines like CopperCore (providing input for standards development).

- Experiment with, and evaluate the usability of the components for learning activities & units of learning.
Research and develop models and methods to stimulate and organise the creation, storage, search, retrieval, use, reuse, pro-active sharing and quality rating of learning activities & units of learning, and identify gaps in our knowledge in this field and develop and contribute to the knowledge in the field.

Thus, WP6 addresses the following Key Objectives of the TenCompetence project [TenC DoW, pp. 5-6]:

- For individuals, groups and organizations in Europe, it is still hard to get an overview of all possible formal and informal units of learning that are available, and to identify the most appropriate for their needs. **WP6 addresses this issue by research and development of innovative, standards-based methods and tools for the exchange and quality rating of formal and informal learning activities and units of learning.**

- For an organization in Europe it is still hard to assess the competencies of applicants, employees and learners who have studied and worked in a variety of settings. **WP6 addresses this issue by developing a formal specification model and supporting tools that combines new assessment types and the ones included in the IMS QTI (providing input for standards development).**

- Current e-learning and knowledge management environments provide too little effective support to the users in their various tasks. **WP6 addresses this issue by research and development of innovative, standards-based methods and tools for the creation, storage and use of formal and informal learning activities and units of learning.**

After the 1st year of project work, the elaborated view of WP6 objectives is the following:

- The term “pedagogical model for competence development” defines the context in which learning activities are carried out, rather than constraining or guiding the choice of pedagogies to be used in any given context (David Griffiths, Initial Review of Pedagogic Models, pp. 6). In TenCompetence WP6 there is a consensus that there is no scientific basis for providing such guidance which is valid for all circumstances, and so it is more appropriate to provide design
methods which support learning designers and practitioners in their practice (Rob Koper, WP6 T6.1 Forum Posts, 13 and 14 April 2006). Thus, Task 6.1 will provide a set of exemplary pedagogical scenarios, focusing on three key directions: flexibility in authoring support, required assessment processes and required communication and collaboration services.

- Practitioners have difficulty understanding the language of IMS Learning Design specification that is needed in order to create Units of Learning. Thus, higher-level graphical Learning Flow tools are needed, which enable practitioners visualize and assemble UoLs more easily (Bill Olivier, WP6 White paper, pp. 9-11). The design paradigm of these tools should be close to the common practice on designing pedagogical scenarios, rather than to the XML-based structure of the IMS Learning Design specification. An important issue here is the machine (automatic) transformation of practitioners’ workflow design paradigms to the lower XML language of IMS LD. Task 6.2 will focus on the design of a new higher-level graphical IMS LD authoring tool that will support learning designers and practitioners in the definition of their UoLs.

- Assessment in competence development is understood as a complex process with many actors, which can and needs to be supported in a variety of ways (Judith Schoonenboom, Working paper on assessment in TenCompetence, pp. 6). Task 6.3 will focus on the definition of the TenC Assessment Specification, aiming to provide the means for defining assessment processes, as an internal part of the design process of a Unit of Learning. Thus, the new assessment specification will be integrated with the IMS Learning Design specification. Special emphasis will be given to support new types of assessment (e.g. 360-degree assessment, portfolio assessment).

- The range of services available in the IMS Learning Design specification is restricted. The current structure for a service in the IMS LD specification essentially maps an open set of roles to a fixed set of service roles. Task 6.4 will focus on the definition of a Connector Protocol, aiming to enable the definition of ‘open services’ in which the service type and role elements are also open. This
would enable any service type, and its specific sets of roles/permissions, to be supported (Bill Olivier, WP6 White paper, pp. 12-13).

- The evaluation of usability of the WP6 components (Task 6.5) is understood as evaluating (a) the flexibility for learning designers and practitioners to define their own pedagogical scenarios, (b) the completeness of the assessment model in supporting existing and new assessment models and (c) the ability of the IMS LD Run-time engines to support pedagogical models that require the use of communication and collaboration services.

**A.2 WP6 Contributions to TenCompetence Domain Model**

The TenCompetence Domain Model v1.0 (Koper, R., 2006) (presented in Figure 1) has been developed in TenCompetence WP2, aiming (among other objectives) to define the overall conceptual architecture.
Based on this Domain Model, WP6 can be divided into three sub-components, namely, the **Authoring Component**, the **Assessment Component** and the **Run-time Component**, with different scope per project implementation phase. Figure 1, presents the TenCompetence Domain Model, whereas, Figure 2 presents the items of the TenCompetence Domain Model which are related to WP6 activities, classified into the three above mentioned components.

**Figure 2: TenCompetence Domain Model items related to WP6 activities**

Each one of these components consists of (a) specifications and (b) tools, and is related to several WP6 tasks described in TenCompetence DoW.

**A.3 WP6 Internal Structure**

Currently, WP6 is organized around three Working Groups, following the three components recognised in the TenCompetence Domain Model. More precisely,

- **WG-A (IMS LD Authoring)**. This Working Group works towards a new 3rd Generation IMS LD Authoring Tool, that will provide support to learning
designers and pedagogical practitioners in using their pedagogic skills to develop Learning Activities and Units of Learning which assist in attaining certain competences. This authoring tool will be based on current state-of-the-art IMS LD authoring tools, such as the ASK-Learning Designer Toolkit (ASK-LDT) and the Reload LD Editor.

The problem to be addressed is that although there are a number of existing IMS LD Authoring Tools (such as Reload LD Editor, CooperAuthor), in TenCompetence a higher-level graphical Learning Flow tool is needed to enable practitioners visualize and assemble Units of Learning easily. The design paradigm of this tool should be closer to common practices on designing pedagogical scenarios, rather than to the XML-based structure of the IMS Learning Design specification.

- **WG-B (Assessment Model)**. This Working Group works towards an Assessment model that combines new assessment types (e.g. 360-degrees feedback and portfolio assessment) and the ones included in the IMS Question and Test Interoperability (IMS QTI) specification.

  The problem to be addressed is that assessment in lifelong competence development is a complex process with many actors, which can and needs to be supported in a variety of ways. Thus, means for defining assessment processes, as an internal part of the design process of a Unit of Learning, are necessary.

- **WG-C (IMS LD Run-time)**. This Working Group works towards a Connection Protocol that will describe how IMS Learning Design Run-time Engines can be connected to external collaboration and communication services, in order to support pedagogical models that require the use of such services (e.g. collaborative learning).

  The problem to be addressed is that the range of services available in the IMS Learning Design specification is restricted. The current structure for a service in the IMS LD specification essentially maps an open set of roles to a fixed set of service roles, limiting the ability of IMS LD Run-time engines to connect to
external communication and collaboration services (e.g. Instant Messaging, Chat services).

The relation of the above mentioned Working Groups with the tasks defined in DoW-1 is depicted in the following matrix, which also presents the achievements of WP6 activities during the 1st reporting period (months 1-12).

<table>
<thead>
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<th>Working Groups</th>
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<th>WGB Assessment Model</th>
<th>WGC IMS LD Run-time Connector</th>
</tr>
</thead>
<tbody>
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<td>T6.1 Research and develop new and existent flexible pedagogical models &amp; learning activity models facilitating and integrating individual learning, collaborative learning, organisational learning and knowledge management.</td>
<td>- A set of examples to be used for proof-of-concept testing of the design of the TenC IMS LD Authoring Tool.</td>
<td>- A set of scenario examples to be used for testing the new assessment specification.</td>
<td>- A set of scenario examples to be used for testing the connection protocol.</td>
</tr>
<tr>
<td></td>
<td>- Representation of pedagogical scenarios in IMS LD templates.</td>
<td>- Representation of pedagogical scenarios in IMS LD templates.</td>
<td>- Representation of pedagogical scenarios in IMS LD templates.</td>
</tr>
<tr>
<td>T6.2 Select and adapt existing tools for the creation, storage, search, retrieval, reuse, support, sharing and quality rating of learning activities and Units of Learning to create the components in the second architectural layer that can be integrated as services at the third layer within the Integrated TenCompetence System.</td>
<td>- Use Cases and Requirements Analysis for IMS LD Authoring Tools.</td>
<td>- Use Cases and Requirements Analysis for IMS LD Authoring Tools.</td>
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<tr>
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<td>- Architectural Design of the TenC IMS LD Authoring Tool.</td>
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</tr>
<tr>
<td>T6.3 Develop a formal specification model and supporting tools that combines new assessment types and the ones included in the IMS QTI (providing input for standards development).</td>
<td></td>
<td>- Use Cases and Requirements Analysis for Assessment Specification.</td>
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<tr>
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<td>- Specification for defining assessment processes, as an internal part of the design process of a UoL.</td>
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<tr>
<td>T6.4 Develop a formal specification to connect communication and collaboration services to LD runtime engines.</td>
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<tr>
<td>T6.5 Experiment with, and evaluate the usability of the components for learning activities &amp; units of learning.</td>
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<td>Not started yet</td>
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</tr>
<tr>
<td>T6.6 Research and develop models and methods to stimulate and organise the creation, storage, search, retrieval, use, support, reuse, pro-active sharing and quality rating of</td>
<td>- Roadmap for further R&amp;D in the field (as proposal for 2nd DoW)</td>
<td>- Roadmap for further R&amp;D in the field (as proposal for 2nd DoW)</td>
<td>- Roadmap for further R&amp;D in the field (as proposal for 2nd DoW)</td>
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1 Template = a complete UoL not populated with resources

TenCompetence – IST-2005-027087 - 16 -
| learning activities & units of learning. |  |  |
B. IMS Learning Design Authoring

B.1 Introduction to IMS Learning Design Authoring for Lifelong Competence Development

B.1.1 Lifelong learning and competence development

It is commonly recognized that lifelong learning is not just one aspect of education and training, but is a guiding principle for provision and participation across the full continuum of learning contexts (Field, 2001). Lifelong learning refers to the activities people perform throughout their life to improve their competence in a particular field (Aspin and Chapman, 2000; Koper and Tattersall, 2004). Competence is seen as the integrated application of knowledge, skills, values, experience, contacts, external knowledge resources and tools to solve a problem, to perform an activity, or to handle a situation (Friesen and Anderson, 2004). In lifelong competence development the learner is self-directed and can perform different formal and informal learning activities in different contexts at the same time. In this context, the focus is on the attainment of complex skills and competences instead of transferring knowledge facts to learners.

Competence-based approaches have the potential to provide important benefits for both individuals and organizations (Draganidis & Mentzas, 2006). At the individual’s level, a competence-based approach may help in identifying competences that need to be developed in order to improve performance, in understanding how to achieve expected performance standards or in aligning individuals’ behaviour with organizational strategies. Additionally, it might assist in increasing consciousness and focus on personal competence development eliminating the gap between available and needed competences (thus, facilitating lifelong learning), as well as, in exposing previously hidden/unknown competences, giving possibilities for new assignments. At the organizations’ level, a competence-based approach may help in identifying competence gaps for each business unit to ensure global competence development in targeted business segments, in designing competence development programmes for improving employees’ performance, in supporting talent management (i.e. global search for identifying employees with high levels of expertise, to further develop these), as well as, in improving effective utilization of the overall human resource potential.
B.1.2 What is a pedagogical model for lifelong competence development?

The e-Framework initiative\(^2\) is an important reference point for the work being undertaken in TenCompetence. Through the e-Framework programme JISC is investing on the creation of pedagogical models. In the report “Review: developing e-Learning Models for the JISC Practitioner Communities. Version 2.1”, Beetham H. identifies 5 ways in which the term models can be understood, which may be summarised as follows:

1. Practitioners tend to use ‘model’ to mean ‘approach to learning and teaching’.
2. Researchers tend to use ‘model’ to mean a way of explaining or exploring what happens in the learning context. Models in this sense generally exist at a higher level of abstraction than practice models and are more explicit about their theoretical commitments (such as cognitive, socio-cultural or cybernetic).
3. The technical development and standards community use ‘model’ in a third sense to mean a way of structuring representations, for example in a given code (e.g. XML) or conforming to a given specification or standard (e.g. IEEE LOM).
4. An important branch of the e-learning literature concerns the institutional and departmental embedding of new technologies, in which ‘organisational models’ play an important role.
5. Learners could be argued to have ‘models’ of e-learning, though these are usually implicit. Learning styles questionnaires and reflective pro-formas (such as the ones that are offered in e-portfolios) represent attempts to make these models more explicit to learners themselves, and therefore available for planning and reflection.

Within the context of the TenCompetence a pedagogical model for lifelong competence development may be understood as a representation of a pedagogic activity using IMS Learning Design, which may or may not be a full Unit of Learning, and which can be used as the basis of authoring and delivering learning activities for the attainment of the desired competences using the TenCompetence infrastructure.

\(^2\) http://www.e-framework.org/
B.1.3 Supporting educational practitioners in designing for lifelong competence development

The term “pedagogical model for competence development” defines the context in which learning activities are carried out, rather than constraining or guiding the choice of pedagogies to be used in any given context (David Griffiths, TenCompetence Initial Review of Pedagogic Models, pp. 6). In TenCompetence, there is a consensus that there is no scientific basis for providing such guidance which is valid for all circumstances, and so it is more appropriate to provide design methods and tools which support learning designers and practitioners in their practice (Rob Koper, WP6 T6.1 Forum Posts, 13 and 14 April 2006). Thus, flexibility in IMS LD Authoring in the context of lifelong competence development is defined as the provision of an inclusive set of methods/tools for learning designers and practitioners in order to support them in using their pedagogical skills to develop learning activities which assist in attaining the desired competences.

In this context, the goal of TenCompetence WP6 IMS LD Authoring Working Group is to provide a framework for supporting learning designers and practitioners through the entire lifecycle of the authoring process, that is, the process of expressing educational scenarios using commonly recognized terms, representing these educational scenarios using a common and interoperable format, and sharing them within a Community of Educational Practice. To achieve this goal, the following key actions have been identified:

- **Definition of Methodological Steps for Expressing Educational Scenarios for Lifelong Competence Development.** Effective sharing of Educational Practices in a Community of Training Practitioners has not yet been realized (Griffiths, 2005), due to the fact that a common and interoperable expression framework for describing such practices does not exist. As a consequence, although practitioners have the ability to share Learning Activities and Units of Learning (via the use of the IMS Learning Design conformant infrastructure), they face difficulties in interpreting the underlying educational approach(es) used, and they cannot reuse...
them neither when delivering activities to their end-users, nor when designing similar learning activities for a different context of use.

- **Design and Development of a High Level Graphical IMS LD Authoring Tool.** Despite the wide adoption of the IMS Learning Design specification, and the existence of a number of IMS LD based Authoring Tools (such as Reload LD Editor, CopperAuthor, ASK-LDT, MOT+), still practitioners face difficulties when designing Units of Learning (Griffiths, 2005). This is due to the fact that practitioners have difficulty in understanding the language of the IMS Learning Design specification that is needed in order to create Units of Learning. Thus, higher-level graphical Learning Flow tools are needed, which enable practitioners visualize and assemble UoLs more easily (Bill Olivier, WP6 White paper, pp. 9-11). The design paradigm of these tools should be close to common practices on designing pedagogical scenarios, rather than to the XML-based structure of the IMS Learning Design specification.

To this end, we start from the definition of exemplary design steps for expressing the main elements of an Educational Scenario when designing Units of Learning for lifelong competence development, and we present examples of vocabularies of common terms that can be used to support the expression process. After that, we apply these design steps in the case of two well known educational strategies (namely, problem-based learning and project-based learning), towards the definition of exemplary Pedagogical Templates that can be used for the case of lifelong competence development. Moreover, we represent these Pedagogical Templates in an interoperable format, that is, the IMS Learning Design specification, integrating the presented Vocabularies of Common Terms with the Information Model of the IMS LD specification.

Finally, based on the presented methodological steps for designing Learning Activities and/or Units of Learning for lifelong competence development, we provide Use Cases of the envisioned IMS LD Authoring Tool, we compare the existing IMS LD implementations based on how well they address the identified Use Cases, and present the proposed architectural design of the TenC IMS LD Authoring Tool, towards
addressing the authoring needs for learning designers and educational practitioners expressed in the Use Cases.

**B.2 Designing Learning Activities for Lifelong Competence Development**

**B.2.1 Competence Development Lifecycle and IMS LD Basic Authoring Steps**

A typical competence development lifecycle (Draganidis and Mentzas, 2006) consists of the following key steps: (a) the creation of a *competence model* through the identification of required job roles and relevant competences, (b) the *assessment of existing competences*, (c) the *gap analysis* between existing competences and the required competences for a specific job role, (d) the definition of *competence development programmes* to minimize the identified gaps and (e) the *continuous performance monitoring and assessment* to confirm improvement. Figure 1, presents exemplary scenarios of the above mentioned lifecycle at individuals’ and organizations level.

Figure 3: Competence Development Lifecycle at different levels
Table 1, presents the mapping of the competence development lifecycle steps mentioned above with the items of the TenCompetence Domain Model (Koper, 2006), partially depicted in Figure 2.

Figure 4: Implementing the Competence Development Lifecycle in TenCompetence (retrieved from TenCompetence Domain Model)

<table>
<thead>
<tr>
<th>Competence Development Lifecycle Step</th>
<th>Related item in TenCompetence Domain Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1. Creation of a competence model through the identification of required job roles and relevant competences</td>
<td>Competence Map, Function/job in Domain</td>
</tr>
<tr>
<td>Step 2. Assessment of existing competences</td>
<td>Competence, Proficiency Level</td>
</tr>
<tr>
<td>Step 3. Gap analysis between existing competences and the required competences for a specific job role</td>
<td>Link between Competence Assessment and Competences, Link between Competence Assessment and Function/job in Domain</td>
</tr>
<tr>
<td>Step 4. Definition of competence development programmes to minimize the identified gaps</td>
<td>Actions, Goal, Competence Development Programme</td>
</tr>
<tr>
<td>Step 4 a. as a synthesis of Units of Learning</td>
<td>Unit of Learning, Unit of Assessment, Activity</td>
</tr>
<tr>
<td>Step 4 b. populated with knowledge resources</td>
<td>Knowledge Resources</td>
</tr>
<tr>
<td>Step 5. Continuous performance monitoring and assessment to confirm improvement.</td>
<td>Result, Competence Assessment</td>
</tr>
</tbody>
</table>

Table 1: Mapping of Competence Development Lifecycle with TenCompetence Domain Model items
According to the above mentioned lifecycle, the process of designing Learning Activities and Units of Learning (individually, or as part of a formal Competence Development Programme) starts when the required competences for a given job role (Competence Model) have been defined, by the execution of a gap analysis between targeted and existing competences. Thus, the design process of Learning Activities and Units of Learning for lifelong competence development consists of the following key steps (Agostinho et. al., 2002):

- **Step A**: Definition of the learning goals (objectives) in respect to the competences to be addressed.

- **Step B**: Selection of Appropriate Educational Approach(es). In this step, appropriate educational approaches are selected either from theory or from practice. The selection is made in such a way to ensure the accomplishment of the desired educational objectives by the targeted audience.

- **Step C**: Description of Learning Activities and Graphical representation of the learning flow. This key step includes the narrative description of the activities contained in a Unit of Learning, as well as, the graphical representation of the learning flow (that is, the flow of activities in a UoL), so as to enable learning designers and educational practitioners have a better overview of the entire learning process.

In the following section, these key design steps are specialized, so as to formulate a design framework for lifelong competence development, that aims to assist learning designers and educational practitioners in expressing their Educational Scenarios (that is, abstract learning flows - learning design patterns - that can be reused in different educational context of use) and Units of Learning, as well as, sharing them within a Community of Educational Practice.

**B.2.2 Basic Steps for Expressing an Educational Scenario and/or Unit of Learning for Lifelong Competence Development**

As described in previous section, the first step when designing Educational Scenarios and/or Units of Learning for Competence Development is to identify the learning goals
(objectives) of this specific Educational Scenario and/or Unit of Learning in respect to the desired competences to be attained.

According to Cheetham and Chivers (1996), competence consists of four main components: knowledge/cognitive competence, functional competence, personal or behavioural competence and values/ethical competence. For simplicity reasons, in the context of the TenCompetence project it was decided that as an initial model for competences we will use three core dimensions (namely, knowledge, skills and attitudes) (Rob Koper, TenC Information Forum Post, December 2005), as depicted in the following matrix.

<table>
<thead>
<tr>
<th>TenC Competence Component</th>
<th>Cheetham and Chivers Competence Core Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Knowledge/Cognitive competence</td>
</tr>
<tr>
<td>Skills</td>
<td>Functional competence</td>
</tr>
<tr>
<td>Attitudes</td>
<td>Personal (or behavioral) competence</td>
</tr>
<tr>
<td></td>
<td>Values/ethical competence</td>
</tr>
</tbody>
</table>

Table 2: Mapping of TenC Competence Components with Cheetham and Chivers Competence Core Components

In order to guarantee the effective sharing of an Educational Scenario and/or a Unit of Learning across a Community of Practitioners, each practitioner should be able to interpret the learning objectives of this scenario and/or UoL. To achieve this, the learning objectives should be described using commonly recognized terms based on the use of a common Taxonomy of Learning Objectives, around the three recognized dimensions of competence (that is, knowledge, skills and attitudes). For this purpose we have selected Bloom’s Taxonomy of Educational Objectives (Bloom, 1956). This taxonomy is organized in three main components-domains, namely:

- **Cognitive Domain**, which focuses on mental skills (knowledge, development of intellectual skills)
- **Affective Domain**, which details feelings or emotional areas (feelings, appreciation, enthusiasm, motivations, attitudes, and values)
- **Psychomotor Domain**, which addresses functional or physical skills (skills)

The mapping of the TenC competence components with Bloom’s learning objective domains is depicted in the following matrix.

<table>
<thead>
<tr>
<th>TenC Competence Component</th>
<th>Bloom’s Learning Objective Domain</th>
</tr>
</thead>
</table>

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An analysis of the Cognitive Domain (related to the Knowledge Competence Component) there exists in the literature (Bloom et. al., 1956), that can serve as the mean for describing learning objectives for attaining knowledge competences. This analysis is depicted in the following table.

<table>
<thead>
<tr>
<th>Learning Objectives Cognitive Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge</td>
</tr>
<tr>
<td>1.1. Knowledge of specifics</td>
</tr>
<tr>
<td>1.1.1. Knowledge of terminology</td>
</tr>
<tr>
<td>1.1.2. Knowledge of specific facts</td>
</tr>
<tr>
<td>1.2. Knowledge of ways and means of dealing with specifics</td>
</tr>
<tr>
<td>1.2.1. Knowledge of conventions</td>
</tr>
<tr>
<td>1.2.2. Knowledge of trends and sequences</td>
</tr>
<tr>
<td>1.2.3. Knowledge of classifications and categories</td>
</tr>
<tr>
<td>1.2.4. Knowledge of criteria</td>
</tr>
<tr>
<td>1.2.5. Knowledge of methodology</td>
</tr>
<tr>
<td>1.3. Knowledge of universals and abstractions in a field</td>
</tr>
<tr>
<td>1.3.1. Knowledge of principles and generalizations</td>
</tr>
<tr>
<td>1.3.2. Knowledge of theories and structures</td>
</tr>
<tr>
<td>2. Comprehension</td>
</tr>
<tr>
<td>2.1 Translation</td>
</tr>
<tr>
<td>2.2 Interpretation</td>
</tr>
<tr>
<td>2.3 Extrapolation</td>
</tr>
<tr>
<td>3. Application</td>
</tr>
<tr>
<td>4. Analysis</td>
</tr>
<tr>
<td>4.1. Analysis of elements</td>
</tr>
<tr>
<td>4.2. Analysis of relationships</td>
</tr>
<tr>
<td>4.3. Analysis of organizational principles</td>
</tr>
<tr>
<td>5. Synthesis</td>
</tr>
<tr>
<td>5.1. Production of a unique communication</td>
</tr>
<tr>
<td>5.2. Production of a plan, or proposed set of operations</td>
</tr>
<tr>
<td>5.3. Derivation of a set of abstract relations</td>
</tr>
<tr>
<td>6. Evaluation</td>
</tr>
<tr>
<td>6.1. Evaluation in terms of internal evidence</td>
</tr>
<tr>
<td>6.2. judgments in terms of external criteria</td>
</tr>
</tbody>
</table>

Table 4: Analysis of Learning Objectives Cognitive Domain (Bloom et. al., 1956)
Similarly, an analysis of the Affective Domain (related to the Attitudes Competence Component) exists in the literature (Kathwohl et. al., 1964) and can serve as the mean for describing learning objectives for attaining attitude competences. This analysis is depicted in the following table.

<table>
<thead>
<tr>
<th>Learning Objectives Affective Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Receiving</td>
</tr>
<tr>
<td>1.1 Awareness</td>
</tr>
<tr>
<td>1.2. Willingness to receive</td>
</tr>
<tr>
<td>1.3. Controlled or selected attention</td>
</tr>
<tr>
<td>2. Responding</td>
</tr>
<tr>
<td>2.1. Acquiescence in responding</td>
</tr>
<tr>
<td>2.2. Willingness to respond</td>
</tr>
<tr>
<td>2.3. Satisfaction in response</td>
</tr>
<tr>
<td>3. Valuing</td>
</tr>
<tr>
<td>3.1. Acceptance of a value</td>
</tr>
<tr>
<td>3.2. Preference for a value</td>
</tr>
<tr>
<td>3.3. Commitment</td>
</tr>
<tr>
<td>4. Organization</td>
</tr>
<tr>
<td>4.1. Conceptualization of a value</td>
</tr>
<tr>
<td>4.2. Organization of a value</td>
</tr>
<tr>
<td>5. Characterization by a value or a value complex</td>
</tr>
<tr>
<td>5.1. Generalized set</td>
</tr>
<tr>
<td>5.2. Characterization</td>
</tr>
</tbody>
</table>

Table 5: Analysis of Learning Objectives Affective Domain (Kathwohl et. al., 1964)

Several taxonomies of learning objectives exist in the literature for the Psychomotor Domain (related to the Skills Competence Component). Examples of these taxonomies are presented in the following table.

<table>
<thead>
<tr>
<th>Learning Objectives Psychomotor Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Simpson, 1972)</td>
</tr>
<tr>
<td>1. Perception</td>
</tr>
<tr>
<td>1. Reflex movements</td>
</tr>
<tr>
<td>2. Set</td>
</tr>
<tr>
<td>2. Basic Fundamental movement</td>
</tr>
<tr>
<td>3. Guided Response</td>
</tr>
<tr>
<td>3. Perceptual abilities</td>
</tr>
<tr>
<td>4. Mechanism</td>
</tr>
<tr>
<td>4. Physical abilities</td>
</tr>
<tr>
<td>5. Complex overt response</td>
</tr>
<tr>
<td>5. Skilled movements</td>
</tr>
<tr>
<td>6. Adaptation</td>
</tr>
<tr>
<td>6. Non discursive communication</td>
</tr>
<tr>
<td>7. Organisation</td>
</tr>
</tbody>
</table>

Table 6: Examples of Taxonomies for Learning Objectives Psychomotor Domain

From these taxonomies we consider as less appropriate for our case the taxonomy provided by Harrow, since it is focused on motor skills rather than generic skills. As a result, for our purpose (that is, designing for competence development) we adopt the taxonomy provided from Dave. Summarizing, the following
The table presents the entire taxonomy that we will use when designing Educational Scenarios and/or Units of Learning, providing detailed description for each element used.

<table>
<thead>
<tr>
<th><strong>Educational Objective</strong></th>
<th><strong>Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge Competence Component</strong></td>
<td></td>
</tr>
<tr>
<td>1. Knowledge</td>
<td>Recall data or information. Development of intellectual skills</td>
</tr>
<tr>
<td>2. Comprehension</td>
<td>Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one’s own words.</td>
</tr>
<tr>
<td>3. Application</td>
<td>Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.</td>
</tr>
<tr>
<td>4. Analysis</td>
<td>Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.</td>
</tr>
<tr>
<td>5. Synthesis</td>
<td>Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.</td>
</tr>
<tr>
<td>6. Evaluation</td>
<td>Make judgments about the value of ideas or materials.</td>
</tr>
<tr>
<td><strong>Attitudes Competence Component</strong></td>
<td></td>
</tr>
<tr>
<td>1. Receiving</td>
<td>Awareness, willingness to hear, selected attention.</td>
</tr>
<tr>
<td>2. Responding</td>
<td>Active participation on the part of the learners. Attends and reacts to a particular phenomenon. Learning outcomes may emphasize compliance in responding, willingness to respond, or satisfaction in responding (motivation).</td>
</tr>
<tr>
<td>3. Valuing</td>
<td>The worth or value a person attaches to a particular object, phenomenon, or behavior. This ranges from simple acceptance to the more complex state of commitment. Valuing is based on the internalization of a set of specified values, while clues to these values are expressed in the learner’s overt behavior and are often identifiable.</td>
</tr>
<tr>
<td>4. Organization</td>
<td>Organizes values into priorities by contrasting different values, resolving conflicts between them, and creating an unique value system. The emphasis is on comparing, relating, and synthesizing values.</td>
</tr>
<tr>
<td>5. Characterization</td>
<td>Has a value system that controls their behavior. The behavior is pervasive, consistent, predictable, and most importantly, characteristic of the learner. Instructional objectives are concerned with the learner’s general patterns of adjustment (personal, social, emotional).</td>
</tr>
<tr>
<td><strong>Skills Competence Component</strong></td>
<td></td>
</tr>
<tr>
<td>1. Imitation</td>
<td>Observing and patterning behavior after someone else. Performance may be of low quality</td>
</tr>
<tr>
<td>2. Manipulation</td>
<td>Being able to perform certain actions by following instructions and practicing</td>
</tr>
<tr>
<td>3. Precision</td>
<td>Refining, becoming more exact. Few errors are apparent</td>
</tr>
<tr>
<td>4. Articulation</td>
<td>Refining, becoming more exact. Few errors are apparent</td>
</tr>
<tr>
<td>5. Naturalization</td>
<td>Having high level performance become natural, without needing</td>
</tr>
</tbody>
</table>
As already described, the goal is to define a framework for sharing Training Practices in a Community of Training Practitioners. Such a framework consists of basic steps for expressing elements/components of an Educational Scenario (e.g. the participating roles, the training environment, the required resources, the interactions between these entities, etc.) and the use of Vocabularies of common terms for defining these elements. The basic steps in order to express an educational scenario that can be represented using the IMS Learning Design specification are presented below.

**Step 1: Educational Scenario Objectives per Competence Component**

During this step, the learning goals (objectives) of this specific Educational Scenario and/or Unit of Learning in respect to the knowledge, skills and attitudes to be attained are defined. For the definition of these learning objectives we propose the use of the taxonomy presented above.

**Step 2: Selection of Appropriate Educational Approach**

In this step, appropriate educational approaches are selected for the targeted audience, ensuring the accomplishment of the desired educational objectives of the didactical problem in hand.

**Step 3: Educational Approach**

**Step 3.1: Educational Principles**

**Case A:** The Educational Scenario expressed is resulted from a specific theory.

In the case that the educational scenario to be expressed is resulted for theory, this step describes the principles of the underlying theory.

**Case B:** The Educational Scenario expressed is resulted from a practice-driven approach.

In the case that the educational scenario to be expressed is resulted a practice-driven approach, this step describes the
ideas (principles) that drive the design of the expressed educational scenario.

Step 3.2: Educational Parameters

During this step the parameters related with the targeted learners of this specific Educational Scenario and/or Unit of Learning (e.g. competences, preferences, cultural characteristics etc) and/or restrictions from the educational context (e.g. available time, existence of assessment, type of required assessment etc) should be specified.

Step 4: Educational Scenario

Step 4.1: Participating roles

An educational scenario consists of a set of activities that are performed by some “roles”. Examples of such roles, depending on the educational approach, can be a learner, a group of learners, a teacher, a moderator in a discussion activity etc. In this step all the required roles by the educational scenario should be defined and properly described.

Step 4.2: Narrative Description

In this step the activities contained in the Educational Scenario and/or Unit of Learning are described in a narrative form, grouped by the corresponding roles that perform each activity.

Step 4.3: Flow of Activities

Activities are the main element of an educational process described by an educational scenario. They relate the participating roles with the educational content (learning objects) and the educational context (learning environment). During this step, the flow of activities (learning flow) executed by a specific role should be specified. The expression paradigm for defining such learning flows is inspired from the Business Process Modeling Notation (BPMN) standard. This standard provides the means for creating human understandable graphical representations of processes, and as such, can be used for defining graphical representations of educational processes described in an Educational Scenario and/or Unit of Learning. The following
The proposed graphical notation to be used for defining the flow of activities is presented in Table 8:

<table>
<thead>
<tr>
<th>Graphical Element</th>
<th>Description</th>
<th>Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pool</td>
<td>A Pool represents an actor (role) in a learning process.</td>
<td></td>
</tr>
<tr>
<td>Lane</td>
<td>A Lane is a horizontal sub-partition within a Pool, for logically organizing and categorizing activities.</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>An activity represents a working item (task) that one or more actors (roles) of the learning process perform.</td>
<td></td>
</tr>
<tr>
<td>Sequence Flow</td>
<td>A Sequence Flow is used to show the order that activities will be performed in a learning process.</td>
<td></td>
</tr>
<tr>
<td>Gateway</td>
<td>A Gateway is used to control the divergence and convergence of Sequence Flow. Thus, it will determine branching, forking, merging, and joining of paths. Internal Markers will indicate the type of behavior control.</td>
<td></td>
</tr>
<tr>
<td>Events</td>
<td>An event is something that “happens” during the course of the learning process. These events affect the flow of the process and usually have a cause (trigger) or an impact (result). Events are circles that internal markers to differentiate different triggers or results. There are three types of Events, based on when they affect the flow: Start, Intermediate, and End.</td>
<td></td>
</tr>
</tbody>
</table>
guarantee the effective sharing of an Educational Scenario and/or Unit of Learning in a Community of Educational Practitioners. This is due to the fact that each practitioner interprets in his/her own way what the activities described in the educational scenario mean. To resolve this problem, each activity defined in an Educational Scenario should also be described using a common vocabulary of terms, uniquely identifiable by practitioners. To this end, we adopt the vocabulary proposed by the DialogPlus Project (www.dialogplus.org), known as, the “Taxonomy of Learning Activities”, with some minor modifications regarding the vocabulary items for the supporting tools and resources for a learning activity. More precisely, in the original Taxonomy of Learning Activities the tools and educational resources were defined as a joint category, whereas, we separate these two types of resources utilized within an activity and extend the vocabulary items defined for educational resources using the vocabulary specified for the “Learning Resource Type” element of the Educational Metadata category of the IEEE Learning Object Metadata (LOM) specification. Thus, we propose the description of a learning activity based on the following key dimensions:

- **Type** of the Activity, answering to what this activity is about.
- **Technique** used in the Activity, answering to how this activity is implemented.
- **Interaction**, describing the interaction between participating roles during the execution of an activity. The interaction is defined, by the type of interaction, the medium of the interaction and the timing of the interaction.
- **Tools**, describing the required hardware and software tools for the execution of an activity.
- **Educational Resources**, expressing the type of the educational resources needed to support an activity.
- **Assessment**, indicating the assessment type that a specific activity uses (if assessment is part of the defined activity).

The following table presents the modified version of the Taxonomy of Learning Activities to be used for describing an activity in the flow of activities.
## TenC Taxonomy of Learning Activities

*(modified version of the DialogPlus Taxonomy of Learning Activities)*

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Technique</th>
<th>Interaction</th>
<th>Tools</th>
<th>Educational Resources (derived from IEEE LOM)</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assimilative</td>
<td>Assimilative</td>
<td></td>
<td></td>
<td>Educational Resources</td>
<td></td>
</tr>
<tr>
<td>Listening</td>
<td>Scanning</td>
<td>Class based</td>
<td>Computer</td>
<td>Exercise</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Reading</td>
<td>Skim reading</td>
<td>Group based</td>
<td>Headphones</td>
<td>Simulation</td>
<td>Diagnostic</td>
</tr>
<tr>
<td>Viewing</td>
<td><em>Information Handling</em></td>
<td>Individual</td>
<td>Lab equipment</td>
<td>Questionnaire</td>
<td>Formative</td>
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<tr>
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<td>Digital image manipulation SW</td>
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<td>Simulation</td>
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**Table 9: Taxonomy of Learning Activities used in TenCompetence**
In the following section, we present examples of applying the above mentioned steps for designing an Educational Scenario, in the case of two well known educational strategies (namely, problem-based learning and project-based learning), towards the definition of exemplary Pedagogical Templates that can be used for the case of lifelong competence development, and represent these Pedagogical Templates in an interoperable format, that is, the IMS Learning Design specification, integrating the presented Vocabularies of Common Terms with the Information Model of the IMS LD specification.

B.3 Exemplified Pedagogical Scenarios (Templates)

In this section, we present exemplary educational scenarios following the design steps presented in previous section. The goal is to create two exemplary Pedagogical Templates (or patterns) that can be used for the case of lifelong competence development (one for problem-based learning and one for project-based learning), and represent them in an interoperable format, that is, the IMS Learning Design specification, integrating the presented Vocabularies of Common Terms with the Information Model of the IMS LD specification. The representation of these pedagogical templates in XML, using the IMS Learning Design specification is depicted in Appendix A and B respectively.

B.3.1 Problem-based Learning

Step 1: Educational Scenario Objectives per Competence Component

In PBL the task for a group of learners is to collaboratively define, analyze, and discuss the real-life problems that they face. Furthermore, their task is to formulate some tentative hypotheses or explanations to the problem by revealing some underlying mechanisms or processes in the problem. According to these tentative hypotheses and explanations, the learners define their learning goals. To achieve the learning goals, the learners have to study external sources of information. Finally, the learners do the synthesis of the material they have studied and may attempt to solve the problem. (Schmidt, H. G., 1983), (Norman, G. R., Schmidt, H. G., 1992)

Apart from process step related objectives, PBL has also got more general educational objectives. First of all, PBL should support the development of general problem-solving skills and strategies through continuous exposure to real-life problems. Secondly, the knowledge that the learners acquire should be more easily
remembered and applied as the learning and application contexts are having certain resemblance. Thirdly, PBL should also have its effect on learners' learning skills, such as self-directed learning skills. Fourthly, PBL should support the intrinsic motivation of the learners, thus making the learning process more motivating and meaningful for them. Lastly, the learners that go through PBL oriented curricula should become more inclined and well-equipped to lifelong learning than their counterparts gone through traditional teaching (Norman, G. R., Schmidt, H. G., 1992). Thus, the learning objectives of this exemplary scenario per competence component are the ones presented in Table 9.

<table>
<thead>
<tr>
<th>Competence Component</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>4. Analysis</td>
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<td>5. Synthesis</td>
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<td>6. Evaluation</td>
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<td>Skills</td>
<td>2. Manipulation</td>
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<td></td>
<td>3. Precision</td>
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<tr>
<td>Attitudes</td>
<td>1. Receiving</td>
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<td></td>
<td>2. Responding</td>
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</tbody>
</table>

Table 10: Problem-based Learning Objectives per Competence Component

**Step 2: Selection of Appropriate Educational Approach**

Since in this exemplar scenario, we start by the decision of applying problem-based learning, so as to reach the accomplishment of educational objectives presented in table 9, this step can be avoided. In any other case that there exist a clear set of learning objectives to be accomplished, this step would include the selection of the appropriate educational approach (or approaches) for the desired learning objectives.

**Step 3: Educational Approach**

**Step 3.1: Educational Principles**

The history of Problem-based learning (PBL) dates back in its present form more than three decades to the late 1960's. It was established in North America universities (especially in McMaster medical school in Canada) teaching the field of Medicine to cope with the problems that started to arose with the ever-growing amount information that accumulated through rapidly advancing research in the fields of Medicine and Technology. The rapid advancements also had their impact
on the demands that new practitioners would face at their future work places. The problems were mainly related to the inefficiency of the old lecturing methods in conveying all the contents and concerns that learning the ever-growing body of knowledge would become inhumane to the learners, when learning in a traditional way (Boud, D., Feletti, G. I. (Eds.), 1997). If PBL is put to its historical context in education, it closely resembles the Deweyian ideas, where it was stated that learners should be facing the real-life problems and be helped to solve them (Spencer, J. A., Jordan, R. K., 1999).

There are various definitions and realizations for PBL. In a general sense, the PBL approach can mean an administrative, curricular philosophy, where the whole curriculum is based on putting the emphasis on solving problems. It can also be seen as an educational method, where the problems are being solved by the learners, who are working in groups collaboratively, which should lead learning concepts and underlying principles in that particular problem-domain. In this template, we are interested in the latter case, where the attention is put to PBL as an educational method. There the new knowledge is created by solving problems in groups, which is very different from the traditional educational viewpoint, where the individually acquired new knowledge is the basis for starting to work on the problems (Spencer, J. A., Jordan, R. K., 1999). There are certain things that are characteristic for PBL as an educational method (Boud, D., Feletti, G. I. (Eds.), 1997):

- The problem examined is bound to the real-life situation, which is also meaningful from the learners’ professional development point of view.
- There are some intellectually stimulating materials that are supporting the learners in their task to solve the problems at hand.
- The learning and problem solving processes, such as limiting the problem space, defining the problem, and creation of plausible solutions, are being tutored by someone, who knows the problem domain (not necessary an expert) and processes in PBL model.
- The learners work collaboratively as a group both inside the class room and outside of it throughout the whole learning process (sometimes excluding the information collection phase).
The goals for the learning and usage of supporting materials should be defined by the learners.

The application of the learned new knowledge in the problem should lead to the solved problem. After the problem is solved, the learning processes are assessed.

There is also a well-known and often used seven step PBL process (Schmidt, H. G., 1983), which is often called in literature as Maastricht "seven jump" sequence (Spencer, J. A., Jordan, R. K., 1999):

1. Term clarification. If there are some terms or concepts that are incomprehensible in the problem, they must first be clarified and agreed upon in a group.

2. Problem definition. Before the problem can be started to be analyzed more deeply, the group has to come into an agreement on the nature of the problem, or what does the problem mean.

3. Problem analysis. In this step the learners can use for example brainstorming as a method to collect ideas concerning the problem. The idea is to clarify the situation by collecting as many explanations to the problem situation and its embedded mechanisms as possible. Here the ideas can be drawn from the previous experience or knowledge, or they can be hypotheses relevant to the problem.

4. Arranging the explanations and hypotheses. Before the learning goals can be derived, the explanations and hypotheses must be collected together and their relationship to the problem at hand and to each other has to be made visible. For example, here a mind map or a concept map can be used as a helping tool.

5. Formulating the learning goals. From the structured set of explanations and hypothesis to the problem, the learners have to prioritize certain topics that they find most relevant to solving the problem. At the same time, they define what needs to be learned in order to be able to justify their explanations and hypothesis.

6. Collection of information. In this step the group collects (usually individually) and analyzes the information, which was decided that it was needed in the
previous step. This can include for example, studying books or online
databases; it can also include consulting experts on that particular topic.

7. Synthesis and application. In the last step the group comes together and makes
a synthesis of the collected information. After the synthesis, the group applies
this newly constructed knowledge to the problem and sees, whether they have
been able to solve the problem successfully. In case the group or its tutor is
not satisfied with the results, the group can go back to previous steps to find
the solution to the problem.

PBL can be seen also as a compound educational method, where various kinds of
educational approaches meet. First of all, it is closely related to the concept of
contextual learning (cf. situated learning), where the learning takes place in a
context, which closely resembles its true application context. In PBL the context is
created with real-life problems (Albanese, M., 2000).

Secondly, it is said that the seven step process of the problem-based learning is
based on the information-processing theory. The information-processing theory
includes three phases: prior knowledge activation, encoding specificity, and
elaboration of knowledge. In the problem-based learning prior knowledge
activation takes place, when learners are creating their own explanations and
hypothesis to the problem. Encoding specificity states that the closer the learning
situation is to the application situation, the more likely the knowledge transfer takes
place. In problem-based learning the problems are closely related to real-life
situations. Elaboration of knowledge is an important part of the last three steps of
the seven step process (Schmidt, H. G., 1983). Thirdly, PBL involves the idea of
cooperative learning, where the learning outcomes are achieved through working as
a group. In PBL, the most of the steps in the learning process involve working and
communicating as a group. Fourthly, if the motivational theories are involved in the
picture, the PBL process involves ideas from the Self-determination theory, where
the autonomous motivators support achieving better learning results. As it can be
seen from the PBL process, the learners are supposed to work autonomously setting
their own goals for learning. Finally, PBL can be seen to involve some flavors from
control theory, where satisfying needs such as freedom, power, love and belonging,
fun, and survival are considered to explain human actions. In PBL freedom comes in the form of freedom to choose when to meet and what to do next, power is the power to decide the learning goals and needs, love and belongingness are important factors when working closely in the group, fun is enjoying one's learning in PBL process, and lastly survival comes in a form of reciprocal help that learners offer to each other (Albanese, M., 2000).

Step 3.2: Educational Parameters

- **Familiarity of PBL process to the learners.** Even nowadays most of the learners are not exposed to PBL or any non-traditional educational approaches during their years in compulsory education. Therefore, before PBL can be applied with the learners, they should be trained to the PBL model and its application.

- **Availability of Real-life problems.** The problems need to be prepared beforehand and they should be as close to the real-life situations as possible. The real-life situation here, means a situation where the learners will most probably find themselves later in their professional careers.

- **Problems of suitable level.** In order for proper learning process to take place, the problems should be suitable for the anticipated level of learners. The suitable level means here that the learners do not have all the required prior knowledge that is needed to solve the problem, so that the need for further learning will emerge. The problem should not be too hard either, so that the learners will be able to begin working on the problem.

- **Availability of supporting material.** The problem solving process can be supported with extra material. There should be enough material that will help the learners to start working on the problems, but not enough to carry them to final conclusions.

- **Role of the learners.** PBL can be seen as a learner centered educational method. The key idea is that the learners are having the responsibility over their learning and that they are supported in their learning process both by material and a tutor.

- **Role of the facilitating tutor.** The tutors, who facilitate the learning process, should understand their role as facilitators of the learning process. The tutors
should not be in the experts' role trying to impose their knowledge over the topic, but let the learners to do their learning and guide them in the matter and keep the learning process going on long enough.

**Step 4: Educational Scenario**

**Step 4.1: Participating roles**

The *learners* are in the very core of the PBL process. They do all the learning activities (concept clarification, problem definition, problem analysis, information collection, synthesis and application) working collaboratively. The real-life problems set by the teacher spark the activities, but the learners are in charge of their learning activities. While they are working, their work is facilitated by the tutor, who is mostly supporting the learning process, not imposing his/her expertise to the learners.

The *tutor* is the one, who has to facilitate the learners' learning process. Facilitation here, means preparing learners for the PBL process, ensuring that all the members of the learner group participate in the activities, preventing the learners from sidetracking too far away, asking questions to make sure that the learners understand what they are doing and what they have learned. In this case, a common assessment process used in PBL is formative assessment, taking place throughout the course instead of being summative and taking place only in the end (Wood, D. F., 2003).

**Step 4.2: Narrative Description**

This exemplified scenario is based on a typical seven step PBL process described in Step 3.1. In addition to those seven steps, two additional steps have been introduced in order to incorporate also the administrative side of the PBL process. Even if the tutor’s role seems to be invisible, it is noteworthy that the tutor basically does the same things in each of the steps, facilitating the learning process through various activities such as asking questions and directing the learning process as explained earlier. To this end, the scenario consists of the following steps/phases:
1. **Preparatory activities.** In this activity the tutor sets the overall, curricular, learning goals for the course, where the PBL is applied. When the learning goals are set, the tutor needs to write or otherwise find suitable real-life problem(s) to be used during the course. Suitable means here problems, which proper solutions will cover the learning objectives and which are not too difficult or easy to the learners. In addition to the questions, the tutor needs to prepare the support material that will help the learners at the beginning of their problem solving process. The preparation of questions and materials are very important activities that create a solid basis for the meaningful learning process to take place and thus ensure the quality of learning in their part. Finally, the tutor has to prepare the learners for the PBL process in case they are not familiar with the process.

2. **Term clarification.** When the learners first encounter the problem, they will start with term clarification. They have to discuss about the terms and concepts used in the problem. After discussion and possible information collection they have to come into mutual agreement about the meaning of previously unknown terms and concepts in problem definition. The learners can use online dictionaries or information databases to support their term clarification process. They can also use any other external sources of information, for example they could ask more information from an expert in this particular topic through some channel of communications (e-mail, SMS, video conferencing, etc.).

3. **Problem definition.** During this phase, the learners will start to define the problem itself. This is done in a manner similar to the previous term clarification, but this time the group of learners has to come to an agreement on the meaning of the problem. It is worth mentioning that in the previous step the attention was put to the terms and concepts that the problem definition includes, but in this step the attention is put on understanding the problem.

4. **Problem analysis.** This phase is often related to the brainstorming method in the PBL literature. The idea is that the learners collect all the
explanations and hypotheses they can come up with based on their prior knowledge and what they think is related to the problem and its internal structure and mechanisms. Here the tutor can facilitate the learning for example, by asking some questions that would lead the learners to take a certain viewpoint to the question that might have otherwise been missed by the learners. In problem analysis it is important to make sure that all the different viewpoints to the problem are recorded.

5. Arranging the explanations and hypotheses. In this step the learners have to elaborate the outcomes of the previous step. They need to figure out the relationships between the various explanations and hypothesis they have created. In addition to the structure inside the outcomes the learners have produced, they have to look also more closely at the relationship that their ideas have with the original problem. Once the learners have organized their outcomes, they have to come to an agreement on deciding which of their ideas sound the most plausible starting points to begin finding a solution to the problem.

6. Formulating the learning goals. After the learners have organized and prioritized their tentative explanations and hypotheses, they define the learning objectives. Defining learning objectives means that the learners identify what they do not know about the matter or what more needs to be known in order to credibly justify and support the explanations and hypotheses to become a solution to the problem. Here the learner group has to divide the work to its participants, so that everyone in the group has got an information collection task.

7. Collection of information. As the learners have identified their learning needs, it is time to start collecting the material that would cover the topics that are imperative to find a justified solution to the problem. The collection and studying of information is mostly an individual process, but goals for this inquiry were decided in a group. At the beginning of their information collection process, the learners may begin with the supporting material that was prepared for them by the tutor. The tutor can also give
some useful tips and hints, where the learners can find the information they need.

8. Synthesis and application. In this phase the learner group comes together and synthesizes the results of individual studies into one coherent entity that should provide the solution to the problem. The learners also have to argue, why the solution that they have provided would be good for the problem at hand. In case that the solution does not seem to fit to the problem, or the synthesis process reveals needs for further studies, the tutor or the learner group can decide to go back to previous steps. This does not mean that the process would start all the way from the beginning, since the learners can use the knowledge and ideas that they have created during the previous steps.

9. Assessment. During this activity, all the participants have the opportunity to express their opinion about the learning process that took place while solving the problem. First of all, the learners self-assess their own learning process and the outcomes that they were able to produce. In some occasions, it is also possible to apply some peer-review to make sure that everyone has equally participated to the group work. Secondly, the tutor, who has followed and facilitated the learning process throughout all the steps, assesses the learners according to their activities and outputs during the whole PBL process. Assessment takes place in a formative manner, which means that the tutor can give feedback to learners throughout the process and not only at the end.

Step 4.3: Flow of Activities

The basic flow of activities for this exemplar educational scenario is depicted in the following diagram. This diagram consists of simple and complex activities. Complex activities are defined as activities that consist of more than one simple or complex activities and can be further detailed by describing their internal flow (the flow of the constituting activities). These complex activities can be seen as micro-scenarios (or micro-templates) that can be combined with other simple activities and/or complex activities to form a complete educational scenario (or educational template).
Problem-based Scenario Example

Tutoring Guidelines

Discussion on Terminology

Discussion on Problem

Brainstorming

Working with peers

Organize into teams

Research

Research

Synthesis

Discussion with peers

Assessment

Assessment

WP6 M6.1 Milestone

Taxonomy of Learning Activities

<table>
<thead>
<tr>
<th>Type</th>
<th>Technique</th>
<th>Interaction</th>
<th>Hardware</th>
<th>Computer</th>
<th>Software</th>
<th>Tool</th>
<th>Resources</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presenting</td>
<td>Presentation</td>
<td>Type</td>
<td>Individual</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Debating</td>
<td>Debate</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Discussing</td>
<td>Discussion</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Debating</td>
<td>Brainstorming</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Classifying</td>
<td>Concept mapping</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Negotiating</td>
<td>Coaching</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Researching</td>
<td>Web search</td>
<td>Type</td>
<td>Group based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Producing</td>
<td>Artifact</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Not Assessed</td>
</tr>
<tr>
<td>Discussing</td>
<td>Peer exchange</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Formative</td>
</tr>
<tr>
<td>Assessing</td>
<td>Test</td>
<td>Type</td>
<td>Individual</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Summative</td>
</tr>
<tr>
<td>Critiquing</td>
<td>Articulate reasoning</td>
<td>Type</td>
<td>Class based</td>
<td>Medium</td>
<td>Online</td>
<td>Timing Synchronous</td>
<td>Hardware</td>
<td>Summative</td>
</tr>
</tbody>
</table>

Figure 5: Exemplary Learning Flow for Problem-based Learning
The above scenario uses two complex activities, namely, the brainstorming and the research activity. The detailed learning flow of these activities is presented below.

**Brainstorming**

<table>
<thead>
<tr>
<th>Learner</th>
<th>Tutor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue</td>
<td></td>
</tr>
<tr>
<td>Initial Ideas</td>
<td></td>
</tr>
<tr>
<td>Working Together and Discuss</td>
<td></td>
</tr>
<tr>
<td>Revise Initial Ideas</td>
<td></td>
</tr>
<tr>
<td>Consensus on set of solutions</td>
<td></td>
</tr>
</tbody>
</table>

**Taxonomy of Learning Activities**

<table>
<thead>
<tr>
<th>Type</th>
<th>Technique</th>
<th>Interaction</th>
<th>Tools</th>
<th>Resources</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presenting</td>
<td>Presentation</td>
<td>Type Individual</td>
<td>Medium Online Timing</td>
<td>Synchronous</td>
<td>Hardware: Computer Software Text viewer</td>
</tr>
<tr>
<td>Writing</td>
<td>Short Answer</td>
<td>Type Individual</td>
<td>Medium Online Timing</td>
<td>Synchronous</td>
<td>Hardware: Computer Software Text viewer Discussion Boards Instant Messaging</td>
</tr>
<tr>
<td>Practicing</td>
<td>Peer Exchange</td>
<td>Type Class based</td>
<td>Medium Online Timing</td>
<td>Synchronous</td>
<td>Hardware: Computer Software Text viewer Discussion Boards Instant Messaging Mind mapping sw</td>
</tr>
<tr>
<td>Debating</td>
<td>Negotiation</td>
<td>Type Class based</td>
<td>Medium Online Timing</td>
<td>Synchronous</td>
<td>Hardware: Computer Software Multimedia viewer Discussion Boards Instant Messaging</td>
</tr>
<tr>
<td>Critiquing</td>
<td>Coaching</td>
<td>Type One to One</td>
<td>Medium Online Timing</td>
<td>Synchronous</td>
<td>Hardware: Computer Software Multimedia viewer Discussion Boards Instant Messaging Mind mapping sw</td>
</tr>
</tbody>
</table>

Figure 6: Brainstorming Complex Activity in Exemplary Learning Flow for Problem-based Learning
B.3.2 Project-based Learning

Step 1: Educational Scenario Objectives per Competence Component

In Project-based learning the learners work collaboratively in projects, that are as close to the real world working as possible. During the projects, the learners are active and self-guided, while the tutor supports them in a way that ensures the educational value of the project. The projects are organized in a manner that they are complex and challenging enough to encourage the learners to learn. Furthermore, the projects are not bound to a specific subject domain, but they are usually multidisciplinary, containing various subject areas. On the more general...
level, Project-based learning aims at giving learners a highly motivating learning experience, which is closely related to the tasks and challenges of the real world. Project-based learning also supports learning the so called “professional skills”, which include skills such as working in teams, working in a self-guided manner, and assessing of own actions. Project-based learning is also connected to the idea of attaining transferable skills such as problem solving.

When looking at the concrete objectives in Project-based learning, the process is aimed at producing an outcome of some kind, which can be either in a physical or in an abstract form. Examples of such outcomes are physical miniature models in a modeling project or a piece of software in a software engineering project. Project-based learning is usually organized in a manner, where both learning of factual and procedural knowledge are present. Thus, the learning objectives of this exemplary scenario per competence component are the ones presented in Table 10.

<table>
<thead>
<tr>
<th>Competence Component</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>2. Comprehension</td>
</tr>
<tr>
<td></td>
<td>3. Application</td>
</tr>
<tr>
<td></td>
<td>4. Analysis</td>
</tr>
<tr>
<td></td>
<td>5. Synthesis</td>
</tr>
<tr>
<td></td>
<td>6. Evaluation</td>
</tr>
<tr>
<td>Skills</td>
<td>3. Precision</td>
</tr>
<tr>
<td></td>
<td>4. Articulation</td>
</tr>
<tr>
<td>Attitudes</td>
<td>1. Receiving</td>
</tr>
<tr>
<td></td>
<td>2. Responding</td>
</tr>
<tr>
<td></td>
<td>3. Valuing</td>
</tr>
<tr>
<td></td>
<td>4. Organization</td>
</tr>
</tbody>
</table>

Table 11: Project-based Learning Objectives per Competence Component

**Step 2: Selection of Appropriate Educational Approach**

Since in this exemplar scenario, we start by the decision of applying project-based learning, so as to reach the accomplishment of educational objectives presented in table 10, this step can be avoided. In any other case that there exists a clear set of learning objectives to be accomplished, this step would include the selection of the appropriate educational approach (or approaches) for the desired learning objectives.

**Step 3: Educational Approach**
Step 3.1: Educational Principles

In Project-based learning, the project, its goals, and its internal processes create together a foundation for collaborative learning to take place. In other words, learning is organized in multidisciplinary projects, where the work is done collaboratively. It greatly differs from the traditional, classroom teaching, where learning is an individual’s own process based on study subjects and their curricula, which are kept apart from each other. The projects in Project-based learning are challenging and complex tasks that are based on some topics, questions, or problems that are driving the working in projects. Challenging and complex tasks here, mean that the tasks must be such that they cannot be accomplished successfully without new learning taking place. The nature of the tasks has to be such that it involves learners in various kinds of activities that support the learning, such as designing, problem-solving, decision making, and active investigation. In projects, the learners work autonomously and collaboratively in small groups, with a tutor facilitating the learning process. The learning is reflective, which means that learners have to reflect on the activities that they have taken and to the outcomes that they have reached. The project at hand usually also involves elements from various subjects, which makes them multidisciplinary and not bound to any particular subject domain. Further features, that define the working and learning in projects, are the authenticity of both the content and ways of working, and educational goals that are visible for the learners from the beginning of the project work. It is also mentioned, that learning in projects involves learning of so called "adult skills", which means the skills needed in working life, such as being able to work in teams (Thomas, J. W., 2000). Belonging partially to the context of adult skills, one important aspect of Project-based learning is the outcomes of the projects, in which usually multiple forms of representation, such as pictorial, verbal, concrete, and abstract, are used at the same time supporting each other (Helle, L., Tynjälä, P., Olkinuora, E., 2006).

Project-based learning can be seen to belong partially to the pedagogical models that put emphasis on the learning-by-doing, where the activities in authentic context are strongly emphasized. What differs in Project-based learning from traditional
learning-by-doing, is that in Project-based learning the doing for the sake of doing is not the core of the learning experience, but the creation of understanding through collaborative activities such as problem-solving or reflection. In a historical context, learning in projects is not a particularly new idea, the earliest documented mentions of projects as an aid for learning date back to the early 20th century. However, during those times the definition of project was more superficial and wide, for example watching a spider to spin its net, or writing a letter were considered to be "projects". Nevertheless, the idea behind that was more or less the same as nowadays, to bind the learning experience closer to its application area, namely the real life (Barron, B.J.S. et. al., 1998). From a motivational point of view, it is suggested in the literature that the motivational elements, such as ownership over the learning process, self-guidance, and challenging tasks, are central, when thinking of the positive learning outcomes in Project-based learning (Helle, L., Tynjälä, P., Olkinuora, E., 2006). Lastly, Project-based learning is also often compared to problem-based learning. These two differ from each other in two significant manners. First of all, in Project-based learning the aim is always to produce an artifact using multiple representations as an outcome, whether it is physical or virtual. Secondly, in Project-based learning the working goes as in "real projects" by doing plans for the activities, conducting those activities, and at the end reflecting on produced outcomes. To put the Project-based learning in a nutshell, it can be defined through the following characteristics (Helle, L., Tynjälä, P., Olkinuora, E., 2006):

- Projects include or aim at finding a solution to a question, challenge, or problem, which may have been set by the learners themselves. Thus, the question or problem drives the activities in a project. The project can also be bound to a certain topic, which in turn drives the activities.

- The learners are in an active, initiative role, where they carry the greatest responsibility over the learning outcomes. Furthermore, the learners work in groups in a collaborative manner.
- The project leads to the end product or a solution of some kind. The end product can be physical such as a rocket in a rocket project or more virtual, such as a working model or a computer program.

**Step 3.2: Educational Parameters**

- *Availability of suitable and authentic real-life topics for projects.* The real-life topics for the learners’ projects must be prepared beforehand. The real-life situation here means a situation where the learners will most probably find themselves later in their professional careers. Projects should also be challenging and complex enough so that they would encourage the learners to learn new things. Additionally, projects should be such that they support in addition to learning factual knowledge learning of procedural knowledge.

- *Learners’ Role.* Project-based learning can be seen as a learner centered educational method. The key idea is that the learners are having the responsibility over their learning and that they are supported in their learning by the tutor.

- *Tutor’s Role.* The tutor supports the learning process by acting as a facilitator to learners. The tutor does not act as an expert who transfers knowledge to learners or directing the activities of the learners, but lets the learners to do their learning and decisions in projects. The tutors’ key responsibility is to follow the projects and support their progress in a way that the learners both acquire the knowledge and skills that the curricula demands, and meet the goals that they have set to themselves.

**Step 4: Educational Scenario**

**Step 4.1: Participating roles**

*Learners* work collaboratively in small groups to create and finalize their project. Working in the project that is bound to the authentic context serves as a motivating way of learning. Learning in the project involves in addition to conceptual knowledge activities that are needed to create an outcome to be presented to others. Working in the project includes elements such as teamwork, communication, design, realization, and assessment that are often considered to be important
“professional skills” needed in the working life. The way of working for learners is active and self-guided.

A tutor acts in this scenario as a facilitator of the learning process. The tutor’s tasks include preparing the learners for project-based learning, especially if the working model is not familiar to them. The tutor may also have to prepare the project topics for the learners, in case the course is designed to be more tutor-lead. Usually the learner groups can decide the topic for their project and it is approved together with the tutor. During the learning process the tutor’s role is to make sure that all the members in the learner groups have enough to do, groups progress in their projects, and that both the expected learning outcomes and the project outcomes become fulfilled.

Step 4.2: Narrative Description

This exemplified scenario is influenced by the SMART (Special Multimedia Arenas for Refining Thinking) blueprint presented by Barron et. al. (Barron, B.J.S. et. al., 1998), as well as, the German six-step model (Tippelt, R. & Amorós, A., 2003). The original SMART blueprint, presented in the figure that follows, was developed as a scaffold for learners and tutors to support their working in projects.

![SMART blueprint scaffold](image)

**Figure 8: SMART blueprint scaffold (adopted from Barron et. al.)**
In the SMART blueprint the problem-based component ensures learning of the conceptual knowledge, which lays a foundation for project-based component, where procedural knowledge is acquired and outcomes created. The conceptual knowledge here means knowledge about concepts, facts, or topics, and their relations to each other, whereas the procedural knowledge is knowledge related to activities taken in real world.

In the German six-step model, the project-based learning starts with the Informing phase, which includes activities to create a conceptual foundation for the project and preparing learners for the project work. In the SMART blueprint, this phase is included in the problem-based learning phase, where learners create their conceptual understanding. The following five steps in the German model are practical steps needed in project work; Planning, Deciding, Implementing, Controlling, and Evaluating. These five steps are similar to the project-based learning phase in the SMART blueprint. The biggest difference between these two models is the more on-going, formative evaluation in the SMART blueprint. Both models put strong emphasis on having learners in the focus of the activities and decision making and supporting the collaborative way of working. To this end, the scenario consists of the following steps/phases:

1. **Project Definition.** In this phase the learners with the support of the tutor, perform a problem-based activity (defined as in previous section), so as to gather the necessary background information for the execution of the project working phase. If both the learner group and the tutor agree on that the project can progress, the learners continue to the next step. Otherwise, the learner group continues building their background knowledge by returning to some of the previous steps (see problem-based activity synthesis and application phase).

2. **Project Planning.** In this phase, learner groups create a blueprint in a form of the project plan for their project work. In addition to deciding the expected outcomes of the project, the learners define the anticipated schedule for their project; the tools that they will be using during the
project work to support achieving the outcomes; and the means to assess their progress and the outcomes. The tutor’s role is to ensure that the learner groups also plan to use methods that will support their learning while doing the project work. An example of such a method is keeping project diaries, which include done activities, reasoning behind the activities, and opinions of the made progress.

3. **Project Execution.** During this phase, the learners working in groups are executing the project work in order to create the outcomes of the project. Usually there are various kinds of outcomes, which can also be referred as multiple representations. For example, a project aimed at creating a piece of software can also include as its outcomes the documentation of that piece of software, a user guide for that software, and a presentation to promote the software. Multiple representations support viewing the project work from different viewpoints and thus enrich the learning experience. This phase also includes following the plans that were done at the previous step and comparing the progress in the project to that of mentioned in the plan. From a learning point of view, it is important in this phase that the learner groups reflect on their activities, reasoning the work that they are doing. Furthermore, the tutor should support the groups in their progress and make sure that all groups stick to the schedules that they have set for themselves. Even though the assessment will be done officially in the next step, the tutor and the learners can use a method of formative assessment in their work. That would ensure the assessment of on-going work instead of relying only on the outcomes in the end.

4. **Assessing the Project Work.** When the learners consider that they have met their goals, it is time to assess the outcomes. The assessment procedure should include in addition to summative elements (the end assessment) some formative elements (on-going work assessment). The assessment itself is done both by the learner groups themselves and by the tutor. When speaking of a formative kind of assessment, it can be supported for example with a semi-structured questionnaire that the learners fill in
weekly. It helps both the learners and the tutor to see how things are progressing and notice early, if something is becoming a problem in the project work. Formative assessment supports assessing the process and its progress in addition to the outcomes they produce. What it comes to the summative evaluation in the end, it can be done for example by assessing the outcomes of the project both in comparison to the learners’ own goals in the beginning and to those demands that the course’s curricula sets to the outcomes. For example, in a software engineering project, the program as a project outcome with its quality and functionality would be under assessment. If both the learner group and the tutor agree on that the project has reached its objectives, the learners can continue to the final step, presentation of the outcomes. Otherwise, the learner group continues refining the outcomes of the project work by returning to one of the previous steps in their project work.

5. *Presentation of the Outcomes to Others.* After the project work is concluded successfully and the outcomes match those that were expected, the learner groups present the outcomes to others. An important part of this phase is learning from the works of the other groups, relating own work to the works of the others, and giving and receiving constructive feedback for the outcomes. In the presentation phase, the learner groups transfer their accomplished outcomes to a shared web space, where the project outcomes are available to everyone taking that course. The web space should support giving feedback to other groups and having discussions about the outcomes and the processes that lead to those.

*Step 4.3: Flow of Activities*

The basic flow of activities for this exemplar educational scenario is depicted in the following diagram. Again, this diagram consists of simple and complex activities. This design flexibility in the aggregation level of activities enables the definition of complex learning designs by reusing as components other simpler designs. An example of this flexibility is presented through the project-based exemplary scenario, where the entire
learning design presented in the previous section for the case of problem-based learning is considered here just one activity in the project-based learning activity flow.
B.4 Use Cases of IMS Learning Design Authoring

From the presented methodological steps for designing Educational Scenarios and/or Units of Learning for lifelong competence development, it is evident that the lifecycle of the authoring process consists of the following key phases:

- Express an Educational Scenario with common terms, that can be identified by learning designers and educational practitioners
- Represent an Educational Scenario in a machine interoperable format, that is, the IMS Learning Design specification
- Populate an Educational Scenario with Educational Resources, so as to create a complete Unit of Learning
- Share an Educational Scenario and/or Unit of Learning within a Community of Educational Practice.

In this section, we present exemplary Use Cases of an envisioned IMS LD Authoring Tool, aiming to support all the above mentioned phases of the authoring process. These Use Cases are presented in a tabular form, providing a narrative description and the flow of events for each one of them.

**B.4.1 Expressing an Educational Scenario**

<table>
<thead>
<tr>
<th>1. Create an Educational Scenario from Scratch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
</tbody>
</table>
**Exemplary Actors**

| Formal Learning | Expert Learning Designer, Educational Practitioner |
| Informal Learning | Individual Learner |

**Basic Flow**

The user initializes the IMS LD Authoring Tool and selects the “New Scenario” option from the menu. The user defines an Educational Scenario by following the next steps:

1. Specify the Learning Objectives of this scenario using a Taxonomy of Learning Objectives
2. Specify the participating Roles in this scenario
3. Specify Environments (tools and services) used in this scenario
4. Specify Activities of this Scenario and describe them using a Taxonomy of Learning Activities
5. Specify the flow of Activities using a graphical representation of the learning flow
6. Specify Conditions upon the flow of activities based on defined properties

The user saves the Educational Scenario as a basis for the production of Units of Learning.

**Alternative Flow**

The user saves the Educational Scenario as a component (into a pool of available components) to be used for the definition of more complex scenarios (see Use Case #2).

**Pre-Conditions**

The user should be aware of the Taxonomies and the Graphical Notation used.

**Post-Conditions**

None

**Specific Requirements**

1. Common Taxonomy of Learning Objectives
2. Common Taxonomy of Learning Activities
3. Graphical Notation for representing the Learning Flow

**Include**

None

### 2. Reuse existing Educational Scenario(s) for creating more complex ones

**Description**

A user of the IMS LD Authoring Tool wants to create an Educational Scenario, by reusing pre-existing Educational Scenario(s) as components of the new scenario.

**Exemplary Actors**

| Formal Learning | Expert Learning Designer, Educational Practitioner |
| Informal Learning | Individual Learner |

**Basic Flow**

The user initializes the IMS LD Authoring Tool and selects the “New Scenario” option from the menu. The user defines an Educational Scenario by following the next steps:

1. Specify the Learning Objectives of this scenario using a Taxonomy of Learning Objectives
2. Specify the participating Roles in this scenario
3. Specify Environments (tools and services) used in this scenario
4. Select from a pool of available components (pre-existing Educational Scenarios) the ones that he/she wants to reuse, by interpreting them via the Taxonomy of Learning Activities used.
5. Specify new Activities for this Scenario and describe them using a Taxonomy of Learning Activities
6. Specify the flow of Components/Activities using a graphical representation of the learning flow
7. Specify Conditions upon the learning flow based on properties defined

The user saves the Educational Scenario as a basis for the production of Units of Learning.

### Alternative Flow
The user saves the Educational Scenario as a component (into a pool of available components) to be used for the definition of another more complex scenario.

### Pre-Conditions
The user should be aware of the Taxonomies and the Graphical Notation used.

### Post-Conditions
None

### Specific Requirements
1. Common Taxonomy of Learning Objectives
2. Common Taxonomy of Learning Activities
3. Graphical Notation for representing the Learning Flow

### Include
None

---

### 3. Modify an existing Educational Scenario

**Description**
A user of the IMS LD Authoring Tool wants to create an Educational Scenario, by modifying an existing one.

**Exemplary Actors**
*Formal Learning*: Expert Learning Designer, Educational Practitioner  
*Informal Learning*: Individual Learner

**Basic Flow**
The user initializes the IMS LD Authoring Tool and selects the “Open Scenario” option from the menu.
The user modifies an Educational Scenario by following the next steps:
1. Select from a pool of available components (pre-existing Educational Scenarios) the one that he/she wants to modify, by interpreting it via the Taxonomy of Learning Activities used.
2. Specify new Activities in this Scenario (or modify existing ones) and describe them using a Taxonomy of Learning Activities
3. Modify (if needed) the flow of Activities using a graphical
representation of the learning flow
4. Modify (if needed)Conditions upon the learning flow based on properties defined
The user saves the Educational Scenario as a basis for the production of Units of Learning.

<table>
<thead>
<tr>
<th>Alternative Flow</th>
<th>The user saves the Educational Scenario as a component (into a pool of available components) to be used for the definition of more complex scenarios (see Use Case #2).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Conditions</td>
<td>The user should be aware of the Taxonomies and the Graphical Notation used.</td>
</tr>
<tr>
<td>Post-Conditions</td>
<td>None</td>
</tr>
</tbody>
</table>
| Specific Requirements | 1. Common Taxonomy of Learning Objectives  
2. Common Taxonomy of Learning Activities  
3. Graphical Notation for representing the Learning Flow                                                                                   |
| Include          | None                                                                                                                                                                                              |
4. Exporting an Educational Scenario to IMS LD

**Description**
A user of the IMS LD Authoring Tool wants to export an Educational Scenario in IMS Learning Design, so that he/she can (a) use any low level IMS LD Authoring Tool to modify/ refine it, (b) use any IMS LD compliant run-time engine to illustrate its use and/or (c) upload it to any IMS LD compliant Web Repository of Learning Designs, so as to share it with others.

**Exemplary Actors**
- **Formal Learning**: Expert Learning Designer, Educational Practitioner
- **Informal Learning**: Individual Learner

**Basic Flow**
The user initializes the IMS LD Authoring Tool and selects the “Export to LD” option from the menu. The user exports the desired Educational Scenario by following the next steps:
1. [Optional] Create the desired Educational Scenario (see Uses Cases #1, #2 and #3)
2. Select the local path for the desired IMS LD manifest
3. Save the desired Educational Scenario in IMS Learning Design XML language

**Alternative Flow**
None

**Pre-Conditions**
None

**Post-Conditions**
None

**Specific Requirements**
None
### Include

- Use Case 1: Create an Educational Scenario from Scratch
- Use Case 2: Reuse existing Educational Scenario(s) for creating more complex ones
- Use Case 3: Modify an existing Educational Scenario

### 5. Importing an IMS LD Educational Scenario

**Description**

A user of the IMS LD Authoring Tool wants to import an IMS LD Educational Scenario so as to be used (a) “as is” for the production of Units of Learning, (b) as a component for the definition of other more complex Educational Scenarios.

**Exemplary Actors**

*Formal Learning:* Expert Learning Designer, Educational Practitioner  
*Informal Learning:* Individual Learner

**Basic Flow**

The user initializes the IMS LD Authoring Tool and selects the “Import LD” option from the menu. The user imports the desired Educational Scenario (represented in IMS LD) by following the next steps:

1. Select the desired IMS LD Educational Scenario (xml manifest)
2. Interpret the Learning Objectives of this scenario via the elements of the Taxonomy of Learning Objectives used
3. Visualize the Learning Flow described within the selected Educational Scenario, to attain an overview of the defined learning process
4. Interpret the semantics of the activities contained in the Educational Scenario via the elements of the Taxonomy of Learning Activities used.

The user saves the Educational Scenario as a basis for the production of Units of Learning.

**Alternative Flow**

The user saves the Educational Scenario as a component (into a pool of available components) to be used for the definition of more complex scenarios (see Use Case #2).

**Pre-Conditions**

The user should be aware of the Taxonomies and the Graphical Notation used.

**Post-Conditions**

None

**Specific Requirements**

1. Common Taxonomy of Learning Objectives
2. Common Taxonomy of Learning Activities
3. Graphical Notation for representing the Learning Flow

### B.4.3 Populating an Educational Scenario with Educational Resources

TenCompetence – IST-2005-027087 - 64 -
6. Generate Units of Learning

**Description**

A user of the IMS LD Authoring Tool creates an Educational Scenario, or selects an existing one from a list of available scenarios, and populates it with educational resources in order to generate a complete Unit of Learning.

**Exemplary Actors**

*Formal Learning:* Expert Learning Designer, Educational Practitioner

*Informal Learning:* Individual Learner

**Basic Flow**

The user initializes the IMS LD Authoring Tool and selects the “Generate UoL” option from the menu.

The user generates a Unit of Learning by following the next steps:

1. **[Optional]** Create the desired Educational Scenario (see Uses Cases #1, #2 and #3)
2. Select from a pool of available Educational Scenarios the desired one, by interpreting it via the Taxonomy of Learning Activities used.
3. Select an Activity within the Educational Scenario
4. Interpret the semantics of the selected activity via the elements of the Taxonomy of Learning Activities used.
5. Inspect the activity metadata to find the type of the required resources for the selected activity
6. Assign appropriate resources to the selected activity
7. Repeat steps 3 through 6 for all activities of the Educational Scenario
8. Select the local path and filename to save the desired Unit of Learning
9. Save the Unit of Learning as an IMS Learning Design Content Package (zip format)

**Alternative Flow**

None
### Pre-Conditions
- The user should be aware of the Taxonomies used.

### Post-Conditions
- None

### Specific Requirements
- Common Taxonomy of Learning Activities

### Include
- Use Case 1: Create an Educational Scenario from Scratch
- Use Case 2: Reuse existing Educational Scenario(s) for creating more complex ones
- Use Case 3: Modify an existing Educational Scenario

---

<table>
<thead>
<tr>
<th><strong>7. Modify the Educational Resources in an existing Unit of Learning</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td><strong>Exemplary Actors</strong></td>
</tr>
<tr>
<td><strong>Formal Learning</strong></td>
</tr>
<tr>
<td><strong>Informal Learning</strong></td>
</tr>
<tr>
<td><strong>Basic Flow</strong></td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
<tr>
<td>6.</td>
</tr>
<tr>
<td>7.</td>
</tr>
<tr>
<td><strong>Alternative Flow</strong></td>
</tr>
</tbody>
</table>

### Pre-Conditions
- The user should be aware of the Taxonomies used.

### Post-Conditions
- None

### Specific Requirements
- Common Taxonomy of Learning Activities

### Include
- None
B.4.4 Sharing an Educational Scenario and/or Unit of Learning within a Community of Educational Practice

8. Publish an Educational Scenario and/or UoL in a Web Repository

<table>
<thead>
<tr>
<th>Description</th>
<th>A user of the IMS LD Authoring Tool wants to share an Educational Scenario and/or Unit of Learning within a Community of Educational Practice.</th>
</tr>
</thead>
</table>
| Exemplary Actors | **Formal Learning:** Expert Learning Designer, Educational Practitioner  
**Informal Learning:** Individual Learner |
| Basic Flow | The user initializes the IMS LD Authoring Tool and selects the “Publish” option from the menu.  
The user publishes an Educational Scenario and/or Unit of Learning to a Web Repository of learning designs by following the next steps:  
1. Select the desired Educational Scenario and/or Unit of Learning to be shared within a Community of Educational Practice  
2. Upload the Educational Scenario and/or Unit of Learning to an IMS LD compliant Web Repository |
| Alternative Flow | None |
| Pre-Conditions | None |
| Post-Conditions | None |
| Specific Requirements | None |
| Include | None |
B.5 Review of existing IMS LD Authoring tools

In this section we present an overview of the existing IMS LD Authoring Tools, aiming to identify how well they cover the Use Cases presented in previous section. The currently available IMS LD Authoring Tools could be classified into two main classes based on the authoring philosophy they implement, namely, first generation and second generation IMS LD authoring tools.

B.5.1 1st Generation IMS LD Authoring Tools

The first generation of IMS LD Authoring Tools, includes tools which provide form-based interfaces for the definition of Educational Scenarios and/or Units of Learning, using the XML structure of the IMS Learning Design specification as the main driver of the authoring process. Depending on the implementation, these tools are tab-structured or tree-based. The main advantage of these tools is that they provide direct control of the Learning Design information model elements. However, they are rather difficult to be used by less experienced designers and they require pre-processing of the structure of the desired scenario in order for a designer to be able to express it directly in XML notation.

Examples of First Generation IMS LD Authoring Tools include:

- The Reload project (http://www.reload.ac.uk/) is built on the developments of the Valkenburg Group (http://www.valkenburggroup.org) concerning Educational Modeling Language (EML) and the associated IMS Learning Design Specification. The Reload Editor, supports authoring of all IMS Learning Design levels through form-based user interfaces (Olivier, B., 2004). Additionally, it integrates a content packaging mechanism that allows exporting of a learning design in the form of a content package.

- The Alfanet project (http://alfanet.ia.uned.es) has developed an authoring tool supporting IMS Learning Design level A and B, which allows a designer to create adaptive Units of Learning. The Alfanet LD Editor is designed reflecting the structure of the IMS LD information model. As a result it provides flexibility in defining activity properties and adaptivity conditions, in balance of user-friendliness (Griffiths, D., Blat, J., Garcia, R., Vogten, H., Wong, K.L., 2005).
- CopperAuthor (http://sourceforge.net/projects/copperauthor) is an open-source form-based editor developed by the Open University of The Netherlands. CopperAuthor supports IMS Learning Design Level A and B, and calls CopperCore (a runtime IMS LD engine developed in the context of the Alfanet project) through web-services to support validation and play of the created Units of Learning (Olivier, B., 2004).

B.5.2 2nd Generation IMS LD Authoring Tools

The second generation of IMS LD Authoring Tools, includes tools which provide graphical-based, drag-and-drop interfaces for the definition of Educational Scenarios and/or Units of Learning. Their main advantage is that they support the design process without requiring pre-existing knowledge of the details of the IMS Learning Design information model. On the other hand, the non-so-close to the XML structure of the IMS Learning Design specification character of these tools, restrains them from offering the full functionality of the IMS LD modeling language to users that need it. Additionally, due to the implementation limitations imposed by the complexity of IMS LD levels higher than level A, most of these tools are only capable of representing Educational Scenarios and/or Units of Learning conformant to IMS LD Level A. In addition, they are able of performing one way conversions, that is, they generate the IMS LD manifest from a graphical representation of the learning flow but not the other way around; these tools are not capable of carrying out the transformation of the IMS manifest to the corresponding graphical representation.

Examples of Second Generation IMS LD Authoring Tools include:

- The MOT+ editor (http://www.unfold-project.net/general_resources_folder/tools/mot) has been developed by the University of Quebec and provides a graphical user interface for describing instructional scenarios. The MOT+ editor can be configured to create learning designs conforming to IMS LD level A (Paquette, G., Teja, I., Leonard, M., Lundgren-Cayrol, K., Marino, O., 2005).

- The LAMS (Learning Activity Management System - www.lamsinternational.com) is a learning management system inspired by EML and IMS Learning Design that provides an authoring tool based on the use of drag-and-drop user interfaces (Dalziel, J.R., 2003, Olivier, B., 2004). The limitation of this environment is that it supports
only linear sequence of pre-defined activities, thus cannot implement complex IMS LD level B Educational Scenarios and/or Units of Learning. However, an export feature in IMS LD Level A has been implemented (UNFOLD Report, 2005).

- The ASK Learning Designer Toolkit (ASK-LDT) (Karampiperis, P., Sampson, D., 2004, Sampson, D., Karampiperis, P., Zervas, P., 2005) is an authoring tool supporting the use of the IMS LD Level A and B specification as the other tools. Although graphical based, it is not as far from the LD specification. This is because its design philosophy allows developers to use a high-level notation in order to define learning scenarios, whereas it internally uses a low level XML-based notation language to describe IMS LD elements. Thus, this tool may be considered as an implementation lying on both worlds: First and Second Generation LD authoring tools. However, this tool does not avoid the pitfalls of either the First Generation of IMS LD authoring tools, since its expression dynamics revolve around the IMS LD specification, or the Second Generation of IMS LD authoring tools, since it does not offer the full functionality of the IMS LD modeling language.

![Figure 10: Overview of IMS LD Authoring Tools](Source: presentation by Colin Milligan on “Learning Design Tools” within the RELOAD project)

**B.5.3 Overview of IMS LD Authoring Tools**

The overview classification of existing IMS LD Authoring Tools is presented in figure 10. From this figure, we can observe that the First Generation of IMS LD Authoring Tools (e.g. Reload LD Editor, Alphanet Editor and CopperAuthor) are closer to the IMS
Learning Design specification than the Second Generation of IMS LD Authoring Tools (e.g. MOT+, LAMS and ASK-LDT).
B.5.4 Comparison of existing IMS LD Authoring Tools

The following matrix presents the list of Use Cases presented in section 4 and their coverage by the existing IMS LD Authoring Tool implementations.

<table>
<thead>
<tr>
<th>Use Case per Authoring Tool</th>
<th>1st Generation Tools</th>
<th>2nd Generation Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reload</td>
<td>Alfabet</td>
</tr>
</tbody>
</table>

### Expressing an Educational Scenario

<table>
<thead>
<tr>
<th>Use Case Description</th>
<th>1st Gen</th>
<th>2nd Gen</th>
<th>3rd Gen</th>
<th>4th Gen</th>
<th>5th Gen</th>
<th>6th Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Create an Educational Scenario from Scratch</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-?</td>
<td>+/-?</td>
<td>+/-?</td>
</tr>
<tr>
<td>2. Reuse existing Educational Scenario(s) for creating more complex ones</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+/-?</td>
</tr>
<tr>
<td>3. Modify an existing Educational Scenario</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+/-?</td>
</tr>
</tbody>
</table>

### Representing an Educational Scenario in a Machine Interoperable Format

<table>
<thead>
<tr>
<th>Use Case Description</th>
<th>1st Gen</th>
<th>2nd Gen</th>
<th>3rd Gen</th>
<th>4th Gen</th>
<th>5th Gen</th>
<th>6th Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Exporting an Educational Scenario to IMS LD</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>+/-?</td>
<td>+/-?</td>
<td>+/-?</td>
</tr>
<tr>
<td>5. Importing an IMS LD Educational Scenario</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>+/-?</td>
</tr>
</tbody>
</table>

### Populating an Educational Scenario with Educational Resources

<table>
<thead>
<tr>
<th>Use Case Description</th>
<th>1st Gen</th>
<th>2nd Gen</th>
<th>3rd Gen</th>
<th>4th Gen</th>
<th>5th Gen</th>
<th>6th Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Generate Units of Learning</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>7. Modify the Educational Resources in an existing Unit of Learning</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>√</td>
</tr>
</tbody>
</table>

### Sharing an Educational Scenario and/or Unit of Learning within a Community of Educational Practice

<table>
<thead>
<tr>
<th>Use Case Description</th>
<th>1st Gen</th>
<th>2nd Gen</th>
<th>3rd Gen</th>
<th>4th Gen</th>
<th>5th Gen</th>
<th>6th Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Publish an Educational Scenario and/or UoL in a Web Repository</td>
<td>-</td>
<td>-</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 12: IMS LD Authoring Use Case Coverage Matrix

**Legend**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>√</td>
<td>Full support of the relevant Use Case</td>
</tr>
<tr>
<td>+</td>
<td>Partial support of the relevant Use Case</td>
</tr>
<tr>
<td>-</td>
<td>No support of the relevant Use Case</td>
</tr>
<tr>
<td>?</td>
<td>Partial support of IMS LD elements</td>
</tr>
</tbody>
</table>
B.6 Proposed Architecture for TenC IMS LD Authoring Tool

From the comparison of the existing IMS LD Authoring Tools presented in the previous section, it is evident that an authoring tool addressing the requirements of the entire lifecycle of the authoring process does not exist. To this end, in WP6 Working Group A (IMS LD Authoring) we aim to design and develop a new IMS LD Authoring Tool that will support learning designers and practitioners through the entire lifecycle of the authoring process, that is, the process of expressing educational scenarios using commonly recognized terms, representing these educational scenarios using a common and interoperable format, and sharing them within a Community of Educational Practice.

In this section we present the architectural design of the envisioned IMS LD Authoring Tool (referred to as TenC IMS LDAT), providing a detailed description of the components/modules comprising the tool.

B.6.1 Overview Description of Proposed Architecture

As described in previous sections, the lifecycle of the authoring process consists of the following key phases:

- Express an Educational Scenario with common terms, that can be identified by learning designers and educational practitioners
- Represent an Educational Scenario in a machine interoperable format, that is, the IMS Learning Design specification
- Populate an Educational Scenario with Educational Resources, so as to create a complete Unit of Learning
- Share an Educational Scenario and/or Unit of Learning within a Community of Educational Practice.

The proposed architecture of the TenC IMS LDAT has been defined in a modular way. Such an approach enables the easier extension of the implemented functionalities, as well as, the reuse of individual components/modules from other open source implementations. The scope of each component/module defined is to directly address the requirements of the relevant authoring process phase.

As a result, the architectural design of the TenC IMS LDAT consists of the following main components/modules:
1. A **Graphical User Interface module** that allows the user to represent graphically the learning flow of an Educational Scenario, as well as, express the defined activities with common terms.

2. An **Inference Engine** that interprets the activity workflow defined in an Educational Scenario and transforms it to the IMS Learning Design XML language and vice-versa.

3. A **Packaging Engine** that enables the association of activities specified in an Educational Scenario with educational resources, and generates Units of Learning (IMS LD compliant content packages in zip format).

4. A **Publishing Engine** that is responsible for making available the created Educational Scenarios and/or Units of Learning on a Web Repository.

<table>
<thead>
<tr>
<th>IMS LD Authoring Process Phase</th>
<th>Responsible TenC IMS LDAT module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A: Express an Educational Scenario</td>
<td>Graphical User Interface module</td>
</tr>
<tr>
<td>Phase B: Represent an Educational Scenario in a machine interoperable format</td>
<td>Inference Engine</td>
</tr>
<tr>
<td>Phase C: Populate an Educational Scenario with Educational Resources</td>
<td>Packaging Engine</td>
</tr>
<tr>
<td>Phase D: Share an Educational Scenario and/or Unit of Learning</td>
<td>Publishing Engine</td>
</tr>
</tbody>
</table>

**Table 13: Mapping of TenC IMS LDAT components/modules to IMS LD Authoring Process Phases**

In the figure that follows the interconnection between the TenC IMS LDAT modules is presented.
B.6.2 Detailed description of individual modules

B.6.2.1 The Graphical User Interface module

The Graphical User Interface module is essential for providing the user with an accessible means of interaction with the TenC IMS LD Authoring tool. The design principles of this GUI are (a) simplicity of the user interface and the representation of a learning flow, so as to enable learning designers and educational practitioners have a better understanding of the designed learning process, (b) hide IMS LD elements that can be directly inferred from the high level design from the user, so as to enable easier assembly of Educational Scenarios and Units of Learning.

The components that comprise the GUI module are the graphical editors for the Activities, Roles and Environments, and the ones that are responsible for the serialization. Accordingly, the functionalities of this module are grouped in the same manner. For Activities, the GUI provides a Graphical Editor with the following basic set of functionalities:

- Definition of Activities and description according to a Taxonomy of Learning Activities
- Definition of the flow of Activities
- Definition of Activity properties and conditions upon the flow of activities
- Definition of a list of Roles participating in each Activity
- Definition of a list of Environments utilized for each Activity

The graphical editor for the Activities provides shapes that represent the Activities in the Activity design area. Activity shapes may be created by making use of the tools available in the tools palette of the editor. The created shapes are resizable and may be connected to each other by specifying types of connections, that is, normal connections and connections that are triggered by conditions. These connections specify the flow of Activities. Every time one of the Activities defined is selected, the Activity properties dialog box is updated to display the properties of the specific Activity. Many of these properties are editable (either through the dialog and/or through the shape representing the activity itself). Through the same dialog box, other dialog boxes are invoked to define the Roles participating in this Activity as well as the Environments for it.
For Roles, the GUI provides a Graphical Editor with the following basic set of functionalities:

- Definition of Roles
- Definition of the connections between Roles (expressing subtypes of roles)
- Definition of Role properties

The Roles Graphical Editor has more or less the same functionality as the editor for Activities. For creating Roles and relations between them, the editor provides a tools palette. This palette helps create Learner and Support Roles, as well as connections between them. Roles can be defined by dragging and dropping Role shapes within the design area of the editor. Once again, these shapes can be manipulated to change their size and properties such as the name of the Role. Only Roles of the same type, that is Support or Learner Roles, could be connected to one another to create sub-type relationships, in order to allow actors to play different roles in certain types of Activity. Properties for Roles may be edited through the properties dialog that is updated with specific Role properties when that Role (represented by its shape) is selected.

For Environments, the GUI provides a Graphical Editor with the following basic set of functionalities:

- Definition of Environments
- Definition of Learning Objects contained within an Environment

The graphical editor for Environments is more simplistic compared to the previous two editors. It too provides a Tools palette to create environment shapes. The user may create Environment shapes using the drag ‘n ‘drop functionality. The user may also provide a name for each environment by editing the environment shape within the design area of the editor.

As for the serialization component of the GUI module the functionalities are the following:

- Creating an Educational Scenario
- Exporting an Educational Scenario in IMS LD (through the Inference Engine module)
WP6 Milestone M6.1

- Importing an Educational Scenario from IMS LD (through the Inference Engine module)
- Saving an Educational Scenario
- Loading an Educational Scenario (that has been created within the TenC IMS LDAT GUI)

Educational Scenarios created from the TenC IMS LD Authoring Tool could be saved following user’s request. Saved Educational Scenarios may be loaded at any time using the load functionality of the module. The GUI also will support the import and export to IMS LD format. Importing an IMS LD representation of an Educational Scenario provides the user with its visual depiction by the GUI module. Exporting an Educational Scenario to IMS LD provides the means for making that entity “playable” by any IMS LD compatible run-time engine. The ability to save to IMS LD is possible through the Inference Engine module. In the same manner, loading a graphical representation of an IMS LD saved Educational Scenario is possible by providing the GUI module with the graphical representation of this Educational Scenario, as output from the Inference Engine module that reads in the relevant IMS LD manifest file.

B.6.2.2 The Inference Engine Module

The Inference Engine is responsible for inferring information from the GUI output, in order to generate the IMS LD XML manifest; it is also responsible for inferring GUI representation information from reading in an external IMS LD XML manifest. The process of inferring IMD LD elements (e.g. Acts, Roleparts and Activity Structures) from the higher level GUI representation of Roles and Activities, and vice-versa is non-trivial. For this reason the Inference Engine comprises a module of its own.

One of the main reasons for using an Inference Engine is keeping the GUI of the LD authoring tool user-friendly. This is done by hiding IMS-LD specific Information from the LD authoring tool user. The Inference Engine is capable of extracting IMS LD elements (e.g. Acts, Roleparts and Activity Structures) from a higher level workflow graph representing the flow of activities. The absence of those IMS LD elements from the interface that is presented to the user, makes the tool more user-friendly and easier to be used from users with less knowledge/experience of the XML structure of the IMS Learning Design specification. Apart from that, the Inference Engine provides a solution
for rendering a graphical representation of an Educational Scenario by transforming the IMS LD manifest from an external source to the GUI high level representation.

The functionalities the Inference Engine module implements are connected to exporting an Educational Scenario into an IMS LD manifest and vice versa. While exporting to IMS LD, the Inference Engine is responsible for performing the following set of tasks:

1. Parsing the high level representation generated by the GUI
2. Breaking up the Play into Acts
3. Defining Roleparts for each Act
4. Defining Activity structures for each Rolepart of each Act
5. Generating the IMS-LD XML manifest

For the first functionality, the Inference Engine uses a parser in order to read in the Activity and Role specific data present in the intermediate GUI output. For the second one, heuristic rules are applied to make clear which Activities are contained within which Acts. Having the Acts of the Play in place, the Inference Engine isolates each Role within each Act and defines Roleparts via the execution of a transformation algorithm. Then for each Rolepart, the Inference Engine defines Activity Structures. These structures contain more than one Activities executed by that Rolepart in a selective or sequential manner, thus forming Sequence and/or Selection Activity Structures. Finally, with all the above information readily available, the Inference Engine constructs the IMS-LD XML manifest.

**B.6.2.3 The Packaging Engine Module**

The Packaging Engine is responsible for associating activities defined in an IMS-LD manifest with educational resources and producing IMS LD conformant Content Packages that can be executed in any IMS LD conformant run-time engine. This module is broken down into two components: the Resource Specification Interface component and the Resource Packaging component. The first is related to the process of associating educational resources to activities within an IMS LD manifest in order to create a Unit of Learning, and the second to the packaging of the manifest file and associated resources.

The list of functionalities for the Packaging Engine Module is grouped into two categories, following the separation between the Resource Specification Interface and the
Resource Packaging components of the module. Through the Resource Specification Interface component the user specifies which resources are associated with activities of an Educational Scenario in order to create a Unit of Learning. This component provides the following functionalities:

- Drag & Drop functionality for associating resources
- Support of multiple files for each resource element
- View Resource Lists for Activities contained in an Educational Scenario, as well as, Learning Objects utilized within an Environment.

The first functionality enables the user to associate resources to an Activity of an Educational Scenario easily. In addition to that, the Resource Specification Interface allows for multiple files to be associated with each resource element, as for example, an html page that contains multiple images, videos, etc. Finally, since Activities and Environments may have resources associated with them, lists of the associated resources may be presented through a dialog for each Activity or Environment to the user. It is important to note that the Resource Specification Interface is integrated within the principal GUI module (although it is an individual element tied functionally only to the Packaging Engine module) of the TenC IMS LD Authoring Tool. The Resource Packaging component has only one functionality:

- Generation of the IMS LD Content Packages (in zip format)

This allows the bundle of the IMS LD manifest file (defining the Educational Scenario) and its associated resources to be compressed within a single zip file. This content package may be stored on the user’s local file system for later use, or be given as input to the Publishing Engine module to be uploaded in a Web Repository of Learning Designs.

**B.6.2.4 The Publishing Engine Module**

The Publishing Engine is responsible for uploading the produced Educational Scenarios and/or Units of Learning to a Web Repository of Learning Designs. The Publishing Engine module enables the user to share Educational Scenarios and/or Units of Learning within a Community of Educational Practice. The Publishing Engine module provides the following basic set of functionalities:

- Publishing an Educational Scenario to a Web Repository of Educational Scenarios
- Publishing a Unit of Learning to a Web Repository of UoLs
The term “publishing” means uploading of Educational Scenarios and/or Units of Learning. Through the GUI component of this module the user accesses the functionalities offered by the Publishing Engine module. Thus, the user is allowed to publish an IMS LD manifest (Educational Scenario) and/or a full IMS LD content package (Unit of Learning).

B.7 IMS LD Authoring Conclusions and Future Work

In TenCompetence, there is a consensus that there is no scientific basis for providing guidance on the choice of pedagogies to be used in a given context, which is valid for all circumstances, and so it is more appropriate to provide design methods and tools which support learning designers and practitioners in their practice. Thus, flexibility in IMS LD Authoring in the context of lifelong competence development is defined as the provision of an inclusive set of methods/tools for learning designers and practitioners in order to support them in using their pedagogical skills to develop learning activities which assist in attaining the desired competences.

In this context, the goal of TenCompetence WP6 IMS LD Authoring Working Group is to provide a framework for supporting learning designers and practitioners through the entire lifecycle of the authoring process, that is, the process of expressing educational scenarios using commonly recognized terms, representing these educational scenarios using a common and interoperable format, and sharing them within a Community of Educational Practice.

Towards achieving this goal, this document defines a set of Methodological Steps for Expressing Educational Scenarios for Lifelong Competence Development, providing examples of vocabularies of common terms that can be used to support the expression process. Based on the presented methodological steps, this document identifies the main Use Cases of the envisioned IMS LD Authoring Tool and compares the existing IMS LD implementations based on how well they address the identified Use Cases. From this comparison, it is evident that, although there are a number of existing IMS LD Authoring Tools (such as Reload LD Editor, CopperAuthor, ASK-LDT), in TenCompetence a higher-level graphical Learning Flow tool is needed to enable practitioners visualize and
assemble Units of Learning easily, that will support learning designers and practitioners through the entire lifecycle of the authoring process. The design paradigm of this tool should be closer to common practices on designing pedagogical scenarios, rather than to the XML-based structure of the IMS Learning Design specification. Thus, in this document the architectural design of the TenC IMS LD Authoring Tool, towards addressing the authoring needs for learning designers and educational practitioners expressed in the Use Cases, is presented.

Future work includes (a) the definition of an algorithm for machine (automatic) transformation of workflow design paradigms to the lower XML language of IMS LD and vice versa, (b) the initial implementation of the TenC IMS LD Authoring Tool prototype, (c) the elaboration of a set of examples to be used for testing the TenC IMS LD Authoring Tool, and (d) the planning and execution of a usability evaluation study (in respect to the provided flexibility for learning designers and practitioners to define their own pedagogical scenarios) of the TenC IMS LD Authoring Tool.
C. Assessment Model

C.1 Introduction

One of the aims of the TenCompetence project is to research and develop innovative, standards-based methods and tools for assessment in lifelong competence development. This chapter presents the results achieved in the area of competence assessment in the first 12 months of the TenCompetence project. In this period, we have addressed three core questions:

- What is competence assessment and how does it relate to competence development?
- How far can today’s e-learning technologies (specifications, models, tools) support the types of assessment needed in competence assessment and in the manner required for lifelong learning?
- Are additional degrees of representation required and if so, can an integrative model be produced as the basis for a new assessment specification?

We address the first question in the section entitled Design Considerations. In the subsequent section, Requirements and Use Cases, we examine two examples of competence assessment, leading to use cases and requirements for the TenCompetence assessment infrastructure. A brief review of existing technical specifications in the area of assessment is then given, together with the results of an investigation of the degree to which these specifications serve the requirements we have identified, providing an answer to the second core question. Finally, we turn to the third question, starting with an introduction to existing work on assessment modelling, before describing modifications identified for application in the TenCompetence context. Chapter C – Assessment model is concluded with two illustrative applications of the TenCompetence Assessment Model in the area of competence assessment in competence development.
C.2 Design Considerations

Developing individuals’ competences throughout their life is a key challenge for today’s knowledge-based society. Learning activities aimed at maintaining or increasing the proficiency levels, referred to as competence development programmes, are a key resource in meeting the challenge. Competence assessment is an important component of competence development, and thus of any competence development programme.

Borrowing the general idea from Hyland 1994, we define competence development as ‘the general development of knowledge, understanding and cognition’ in a person with respect to a specific domain. In our definition, competence development has the following characteristics:

1. It is about personal understanding, thus the emphasis is on the individual learner.

2. Competence development is an ongoing process through life, thus it is strongly related to lifelong learning.

3. All activities that a person undertakes may contribute to competence development. Competence development is not related to specific types of learning activities, thus competence development involves informal learning; formal learning might be involved, and will be in most cases, but this is not a necessary element.

We agree with Brugman (1999), who, in developing his definition of competence development, states that ‘what is needed is not only a definition of competence development, but also an understanding of variables that affect competence development’. Insight into these factors is a necessary prerequisite when thinking of how to support competence development. A first characteristic of our approach is the importance of learner goals. Learner goals are the drivers for individuals to engage in competence development. Following the TenCompetence Domain model, we claim that support for competence development should provide support to lifelong learners with any of the following goals:

1. I want to keep up to date within my existing function or job.
2. I want to study for a new function or job or improve my current job level

3. I want to reflect on my current competences to look which functions and jobs are within my reach or to help me define new learning goals

4. I want to improve my proficiency level of a specific competence

5. I want some support on a non-trivial learning problem

6. I want to explore the possibilities in a new field (learning network) to help define new learning goals

We consider all activities a learner undertakes to reach these goals as activities of competence development. Brugman’s phrase of ‘competence development opportunities’ captures this notion well. Note that this diversity of activities fits in well with our broad definition of competence development. A second characteristic of our approach is that competence development is seen as a process. This is a characteristic of several approaches to competence development – see also (Brugman, 1999).

**C.2.1 What is competence assessment?**

We define competence assessment as the assessment of what a learner has learned with respect to a specific competence. This straightforward definition can be used to distinguish competence assessment from other types of assessment (although competence assessment is usually based upon more advanced forms of assessment, using these techniques in assessment does not necessarily lead to competence assessment).

The first aspect that distinguishes competence assessment from other forms of assessment is a notion of completeness with respect to the competence involved. Competence assessment assesses the proficiency level of a specific competence as a whole, not only a part of that specific competence. This is in line with the definition of Cheetham and Chivers (2005, p. 54) of competence: ‘Effective overall performance within an occupation, which may range from the basic level of proficiency through to the highest level of excellence’, and of professional competence: ‘the possession of the range of attributes necessary for effective performance within a profession, and the ability to marshal these consistently to produce the desired overall results’. This idea of completeness is reflected in competence assessment practice which typically takes into
account several types of evidence. According to Eraut and Cole (1993), assessment of professional competence requires two types of evidence:

- performance evidence – this is evidence drawn from the application of both specialist and generic skills in a professional context; and
- capability evidence – this is evidence, not directly derived from the workplace, which is used either to supplement performance evidence or to ascertain a candidate’s potential in the future.

A second distinguishing characteristic is that competence assessment is not necessarily coupled with specific training. Duvekot (2005) describes competence assessment as assessment ‘of what an individual has learned [with respect to a specific competence] in every possible learning environment, including both formal and informal learning environments’. Competence assessments differ from assessments that aim at testing whether the knowledge and skills taught in a specific course or training have been acquired. The separation of training and assessment therefore is basic to competence assessment. Defining competence assessment in this way reveals that the problems related to competence assessment differ from those related to other types of assessment.

- One important issue in traditional assessment is alignment, the correspondence between the content and educational formats of the training and assessment. Alignment between training and assessment does not play a role competence assessment, although, in the setting of competence assessment in education, training and courses should cover the competences to be acquired. In contrast, alignment between competence assessment and what professionals actually do in practice is of utmost importance. According to McGaghie (1993), methods of assessment should closely match what professionals do in practice.
- In contrast to traditional assessment, accessibility plays a role in competence assessment.
- Another difference between competence assessment and traditional assessment is that competence assessment is typically delivered in intervals ranging from months to years.

- Competence assessment is based on output. As a consequence, new learners have to become used to thinking of themselves not as someone starting a qualification path from scratch, as an empty bottle (after having acquired the entrance level), but rather as someone whose bottle, compared to the final achievement levels, is already partly filled. Putting output central implies that changes in output also become central. This puts emphasis on the need for intermediate assessment when output qualifications change, and the need for alumni to regularly update their qualifications.

C.2.2 Processes in competence development and competence assessment

Our approach to competence assessment starts from the position that it plays different roles in the different stages of competence development. We first examine the stages of competence development from a number of different perspectives before examining the nature of competence assessment.

C.2.2.1 Perspectives on processes in competence development

C.2.2.1.1 The learning theory perspective

Many approaches to lifelong learning and adult education refer to experiential learning theory, as developed by Kolb (Osland, Kolb, & Rubin, 2001). According to (Hyland, 1994): ‘Kolb offers a useful summary of the key features, noting distinctive emphases on learning as a continuous process grounded in experience, on the idea of a holistic process of adaptation through the resolution of conflicts and opposing viewpoints, and on the notion that learning needs to be regarded as a means of creating knowledge rather than merely repeating and reinforcing existing traditions. Kolb aggregates all these ideas in his broad definition of experiential learning as 'the process whereby knowledge is created by the transformation of experience' (1993,p. 155).’ Brugman (1999:39-40), referring to Kolb, describes the process of competence development as ‘consisting of a person acting in a context, observing the effects of his
actions, reflecting on it cognitively, his mental and physical constitution becoming used or adapted to the actions and environment, thus slowly changing the person’s capacity for subsequent performances’.

According to Hyland, experiential learning theory has emerged as the preferred methodology within adult education (Mezirow, 1983) and, in a slightly more practical form, is the most influential model in the further education sector (Gibbs, 1988). Based on the idea of experiential learning, (Michael Eraut, 1994) describes a model of professional development, ‘originally devised in the study of airline pilots and chess players, which consists of a five-stage description of skill acquisition: novice, advanced beginner, competent, proficient and expert’. In this model, competence is just one stage of development and a competent practitioner would only be around half-way to the realisation of full potential in any particular professional sphere (Hyland, 1994).

In these approaches, the emphasis is on the learner. Brugman adds that ‘from the perspective of managing competence development, this notion implies that managerial attention can be given to the process of competence development, and therefore to the cycle of performance – reflecting upon the performance – subsequent performances etc. in relation to a specific development context (Brugman, 1999, pp. 39-40). In conclusion, from the perspectives of learning theory, at least two different process models can be derived. One, directly based on Kolb, including stages of experience, observation, reflection and adaptation, and one model based on stages of expertise in which the learner progresses through the stages: novice, advanced beginner, competent, proficient and expert.

C.2.2.1.2 THE VALIDATION OF PRIOR LEARNING PERSPECTIVE

Another perspective on competence development is that of the Valuation of Prior Learning (VPL). VPL is relevant when an individual, having acquired certaining competences in both formal and informal learning, enters formal education. According to Duvekot (2005, p. 12), VPL aims at recognition, accreditation/validation and further development of what an individual has learned in every possible learning environment, including both formal and informal learning environments. Duvekot distinguishes a narrow or summative approach of VPL, which focuses on an overview of competences,
the cognition and validation and which is retrospective. The broad or formative approach of VPL includes stimulating actual learning or knowledge development. This approach is prospective and aims at development. Duvekot (2005, p. 17) distinguishes between five phases of the VPL procedure:

1. commitment and awareness – individuals become aware of their competences, organizations become aware of the importance of lifelong learning and VPL
2. recognition – identifying or listing competences, usually in a portfolio
3. the valuation or assessment of competences – using the portfolio or additional assessments
4. the development plan or the actual valuation – the valuation is turned into an action plan
5. structural implementation of VPL – VPL is structurally integrated into the organization

In this approach, both learners and organizations are involved in competence development. In phase 1, both individuals and organizations become aware of their competences, and in phase 5, VPL is integrated into the organization.

C.2.2.1.3 The organizational perspective

From an organizational perspective, competence development is often called ‘competence management. Van Dongen (2003) provides an example of this approach. The introduction of competence management in an organization is depicted by Van Dongen as follows:

<table>
<thead>
<tr>
<th>orientation</th>
<th>inventory</th>
<th>Profiling</th>
<th>diagnosis</th>
<th>planning</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan the introduction of competence management</td>
<td>Determine existing core competences (once-only)</td>
<td>Determine desired competences</td>
<td>Measure competences present</td>
<td>Plan action based on gap between competences desired and present</td>
<td>Implement action plans</td>
</tr>
</tbody>
</table>

Management and personnel department (HRM)

| Individual employees |
As in the VPL approach, there is interplay between the organization and the individual. This complex interplay is further elucidated by Duvekot (2005), who distinguishes three levels:

- individuals need to be able to take control of their own learning and career in order to become or stay employable.
- Organizations need to be able to facilitate these individual learning paths and make use this within the context of their own mission/goals.
- The learning system – vocational education and training (VET), guidance and counseling – and other services to individuals – labour agencies, local communities and welfare – needs to adapt itself to rendering flexible services to these individuals and organizations.

C.2.2.1.4 Perspectives on processes in competence assessment

Perspectives on competence assessment focus on one specific part of competence development, namely the assessment. Looking at the process of the competence assessment itself, Fletcher (2000) distinguishes between the following stages:

1. State required criteria for performance (What are the required outcomes of individual performance?)
2. Collect evidence of outcomes of individual performances
3. Match evidence to specified outcomes
4. Make judgements regarding achievement of all required performance outcomes
5. Allocate ‘competent’ or ‘not yet competent’ rating
6. If purpose of assessment is certification: Issue certificate(s) for achieved competence
7. Plan development for areas in which ‘not yet competent’ decision has been made

The TenCompetence domain model similarly distinguishes between:
1. Identifying competences (given a certain function/job) that have to be estimated.

2. Gathering evidence (eg by using tests, by asking diploma’s, etc.) for the competencies

3. Making the decision on the proficiency levels an actor has acquired

4. Making a decision on whether a person complies to the requirements of the different function/job levels to determine at which role level he/she functions.

From the perspective of setting up an assessment centre, the focus is on the assessment organisation. Woodruffe (2000) distinguishes between:

- Competency analysis
- Development of exercises
- Observing and recording exercises
- Feedback on exercise performance
- Development planning

As stated above, competence assessment, like competence development, can be considered a process. In that process also, a complex interplay exists, not so much between individuals and organizations, but rather between learners and assessors.

**C.2.3 Integrating competence assessment in competence development**

In this section, a model is developed in which the processes of competence development and competence assessment are integrated. This model distinguishes several stages in competence development / assessment, which are based on the stages in the several perspectives presented previously, and at the same time they are true to our definitions of competence development and competence assessment that have also been presented. In our definition learners’ goals are central to competence development. Figure 1 displays the four stages of competence development. Each stage is labelled by a header, and below the header the learner goals corresponding to that stage are presented.
The cycle of competence development starts with a process of orientation in which the learner determines which competences s/he wants to develop. Once this decision has been made, the learner has a choice. One possible route is to proceed by collecting evidence, which shows the learner’s current proficiency level. The other route is to proceed directly to execution of a personal development plan. From the collection of evidence, the learner can choose: either they can have their proficiency level officially recognized by others, or they can proceed by setting up a personal development plan and executing that plan. The latter route is the informal learning route. Note that in this route, some sort of valuation is involved, as it is necessary that the learner determines what their own proficiency level is, and what aspects of their competence they should develop further. Yet, this very light form of self-valuation is completely different from assessment by others, which is an essential part of what we might call the formal learning route. Yet it is very important to realize that the formal learning route is not completely formal. In fact, assessment by others is the point where the formal learning route starts, where previous learning, which might have been either informal or formal, is turned into a formal recognition. When the cycle is followed for the first time, the moment of assessment by others represents a so-called intake assessment. Also, assessment by others is the only moment in which there is direct contact between the learner and the assessor. In other situations, contact between learner and assessor is only indirect, in that it is the
This cycle of competence development is to a large extent based on Duvekot (2005). Yet, true to our focus on the individual learner, those aspects that relate to the learning organisation, such as the awareness of organisations and the structural implementation of VPL, are omitted. Another point of difference is that VPL is necessarily concerned with formal learning, namely with valuating former informal learning in a formal learning setting, whereas in our approach a completely informal learning route is very well possible. Therefore, in Duvekot’s model, assessment by others is a necessary part, whereas it is optional in our model.

**Figure 13: Function and forms of assessment in the cycle of competence development**

We note that the assessment stages of Fletcher (2000) and the TenCompetence domain model overlap with our cycle of competence development to a large extent. True to our focus on the individual learner, the competence development cycle starts with the orientation phase in which the learner determines which competences should be developed. This first stage is the same as the first stage of the TenCompetence domain model, but it differs from the first stage by Fletcher, who emphasises the institutional side.
The second stage is the stage of evidence collection, which is Fletcher’s stage 2 and TenCompetence Domain model stage b. The third stage is the stage of assessment by others, which encompasses Fletcher’s stage 3, 4, 5, and 7 and TenCompetence Domain model, stage c and d. Note that the last stage of the competence development cycle, is not included in either model of competence assessment. An important difference between our competence development model and both assessment models is that their focus is on the assessment by others. Most of their stages are in our models included in the stage ‘assessment by others’. In their assessment models, collecting evidence is seen as a preparatory stage for assessment by others, whereas in our model it needn’t be followed by assessment by others.

Another difference between our model and much of the literature is our coupling of assessment forms with competence development stages. In the literature, this link is absent, or at most mentioned vaguely. There is recognition in the literature that several assessment forms are needed. In the definition given by (Joosten-ten Brinke et al., In press) assessment includes ‘classical tests, examinations and questionnaires, as well as newer types of assessment, such as performance assessment, portfolio assessment and peer assessment’. (Liesbeth K. J. Baartman, Bastiaens, Kirschner, & Vleuten, 2006) and (Liesbeth K.J. Baartman, Bastiaens, & Kirschner, 2004) distinguish between ‘newer’ and ‘older’ forms of assessment (without specifying which forms are what). They also claim that a competence assessment programme should use both types, because all methods of assessment may contribute to the difficult job of determining whether a learner has acquired a competency. They agree with (Cizek, 1997) that newer forms of assessment are not meant as alternative ways of gathering the same kind of information about learners, but as ways of answering completely different questions. Many of the newer forms of assessment were developed with the idea of measuring deeper understanding. Yet, they do not couple forms to stages in competence development. Duvekot comes most close to our approach, as he couples self-assessment to the orientation stage, but his emphasis is on VPL, and does not include the stage of following a competence development programme.
In our view, being assessed by others is just one option among many others. Learners may, after a short orientation, directly start with executing a personal development plan, or they may want to list their competences without having these assessed, or they even simply may want to do an orientation without a continuation. Thus, as the four stages can be followed relatively separate from each other, the functions that competence assessment might have in all of these four stages should be included in a model of competence assessment. Traditionally, reflected in Fletcher’s model and the TenCompetence domain model, the function of assessment is to judge the proficiency level of the learner. This puts an emphasis on the ‘Assessment by others’, which has this function, and includes the evidence collection, which is seen as a preparatory stage to assessment by others.

The other two stages of competence development are traditionally not included in descriptions of competence assessment. Yet, from other sources, it is clear that competence assessment may have a function in these stages as well. In the orientation stage, competence assessment might provide feedback on self-analysis of the learner as to their current proficiency level regarding competences that they might decide to develop further. During the execution of the personal development plan, assessment might help in steering or adjusting the plan. The next sections discuss these assessment types for each of the stages.

**C.2.4 Assessment in the four stages of competence development**

**C.2.4.1 Stage 1: Orientation**

In Duvekot’s VPL model, the process through which a learner goes in the first orientation phase can be described as follows:

1. self-examination: the learner investigates his/her own current competence level. First, the learner determines the level more generally (‘I am at university education level’). Then, the learner determines his/her likelihood of success for separate domains.

2. self-assessment: the learner determines which experiences, knowledge and skills s/he possesses.
3. orientation: the learner looks where s/he can find information on the possibilities for competence development.

In his view, the investigation of learners into their competences is very much supported by self-examination and self-assessment. This is in line with McGaghie (1993), who states that more attention should be paid to what they call ‘pre-entry assessment’. This term reflects the view of both authors, who view self-assessment in the orientation stage as a preparation to the formal assessment by others later-on in the process. According to Duvekot (2005, p. 50), as much as possible self-examination by the individual of the own targets, wishes and possibilities in the orientation stage increases the accessibility of the assessment by others. In our model, self-assessment in the orientation stage has a broader function. Not only is it a preparation to a formal competence development program, which involves assessment by others, it may also be a preparation of an informal competence development program, in which orientation is directly followed by executing a personal development plan. In summary: in our model, self-assessment in the orientation phase functions as a preparation for executing a personal development plan, rather than a preparation to assessment by others.

C.2.4.2 Stage 2: Evidence collection by the learner

During the stage of evidence collection, the learner builds a portfolio, listing evidence for their current proficiency level. In general, assessment models recognize evidence collection as a separate stage. Viewed through time, this is done rightly: the process of evidence collection might take a long time, even several years.

The ‘assessment’ method in this stage revolves around the portfolio. Portfolio building has recently become a very important instrument, and the cycle of competence assessment includes portfolio building as a separate stage. One of the reasons for the growing importance of portfolio building is a reversal in the burden of proof. In traditional competence assessment, the assessor asks the learner to prove that s/he possesses the required knowledge and skills. This is shifting towards a situation in which learners take their portfolio to the assessor, and the assessor has to prove that the individual does not possess the required knowledge and skills. As a result, the emphasis in assessment is shifting from the moment of assessment by the assessor to the collection
of evidence by the learner earlier in the process. Learners now have the task of presenting a portfolio which will be convincing of his or her qualities. This also means a shift away from the assessor (which becomes important at the moment the assessment comes into view) to the individual, who is central in the preceding course of collecting evidence.

This shift in the burden of proof fits very well with the idea that portfolio building might but needn’t be followed by assessment by others. The emphasis is on the evidence collection by the learner, whether or not this is followed by assessment by others.

C.2.4.3 Stage 3: Assessment by others

After having gone through the individual part of assessment, the learner may want to go to an assessor to have their competence level assessed. The task of the assessor is to match the output that the individual provides to the output levels of the qualification. In Duvekot’s model, assessment by others consists of three steps: (1) setting the standard for valuation, which can be any standard that matches the need of the organization, be it a national or an internal standard. (2) the valuation itself, and (3) the validation of the learning evidence within the given standard. The result of valuation is a validation of the learning evidence (step 3): which can take diverse forms such as a certificate, diploma, career move, or advice on career opportunities. McGaghie (1993) stresses that methods of assessment should closely match what professionals do in practice. According to Eraut and Cole (1993), evidence based directly on performance in the workplace should be given a high priority, but they point out that relatively few professions have clear, objective standards against which such assessments can be carried out. McGaghie criticizes current assessment methods as inadequate for addressing the complexities of professional competence. McGaghie gives primacy to direct observation of professional activity in addition to knowledge assessment of acquired knowledge. He leans towards the use of simulations, providing they are of high fidelity, and also favours ‘open-ended’ problem solving exercise.

In our model, the assessment by others is the only moment when learners and assessors meet and interact with each other. This happens only after the learner has already gone through an individual process of orientation and portfolio building. This is
true, even if the assessment concerned is the learner’s first assessment, a so-called ‘intake assessment’. Several people are involved in assessment by others, in different roles.

Assessment by others comes in many forms. Cheetham and Chivers list the following types of competence assessment: direct observation, production of a portfolio of evidence, sometimes verified by a senior member of the profession. In our view, these all refer to assessment by others. Cheetham and Chivers further distinguish three ‘broad patterns of assessment’:

- assessment of workplace performance during a period of practical experience, following completion of an academic qualification in Higher Education
- on-the-job assessment as an integral part of the academic qualification leading to direct professional recognition; and
- assessment of practical performance conducted both within the academic course and during a subsequent period of professional experience.

The most common assessment techniques identified by Eraut and Cole (1993) are: direct observation by supervisors; the use of role plays or simulations; observation of simplified practice; indirect observation using a video recording; interviews with candidates; and the examination of work related documents – e.g. portfolios, records, testimonies.

As mentioned above, the portfolio is a very important assessment technique. Duvekot (2005) mentions the valuation of the portfolio as the most important part of assessment which is ‘when necessary, followed by an extra assessment’. This assessment usually takes place by observation during work or by means of a criterion based interview. In Duvekot’s model, the most important part of valuation consists of the assessment of the portfolio and its valuation with respect to the given standard and targets of the organization. Valuation of the portfolio can be followed by an extra assessment. This assessment usually takes place by observation during work or by means of a criterion based interview. Assessors compare the competences of an individual with the standard used in the organization involved.
C.2.4.4 Stage 4: Execution of personal development plan

During the execution of the personal development plan, assessment might be a help in steering or adjusting the plan. In this stage, peer assessment and self-assessment play an important role.

C.3 Requirements & Use Cases

The analysis described in the previous section reveals that since the forms of assessment differ in each stage of competence development, the forms of infrastructural support needed with these assessments are different. Which functions within the various assessment types should be supported by an infrastructure such as that being developed in TenCompetence? In this respect, three different types of assessment can be distinguished, each with their own general support needs.

We distinguish between self-assessment, occurring in the orientation and execution stage; evidence collection (=stage 2) and assessment by others (= stage 3). Figure 14 provides examples of support that can be provided with these three types of assessment. Self-assessment, both in the orientation and execution phase can be supported by progress testing; evidence collection can be supported by automatic evidence distillation and the use of an e-portfolio and assessment by others can be supported by learning designs.

Figure 14. Assessment functions to be supported in the different stages of competence development and examples of e-support
**Self-assessment**

The main function of self-assessment is to provide the learner with feedback, either with feedback on their current proficiency level with respect to a specific competence or with feedback indicating which competences might be of interest for development. With this function, one existing type of e-assessment might especially be of interest and that is progress testing. Progress testing is a type of assessment which has been in use with problem-based learning. In formal education programs based on problem-based learning, a progress test is a general test which involves the whole competence domain. The progress test is administered four times a year, and consists of around two hundred multiple choice questions, taken from a large question bank. All Learners, whether they are freshmen or in their last year, have to take the same test. Of course, the more advanced the Learner is in the programme, the better the results will be, in general. The test consists of subject matters at the final achievement levels, selected in proportions that reflect the relevance of the different subject materials in daily practice (Delhoofen, 1996). The main reason for this quarterly progress test is that individual learning pathways of Learners in problem-based learning can be considerably different. That makes is an interesting test to be used in life-long learning, due to the divergent learning pathways which can be seen.

**Evidence collection**

With evidence collection, mainly two functions have to be supported. First, the learner should have the opportunity to store and retrieve information on their proficiency level. The widely used e-tool with this type of support is the e-portfolio. The second function to be supported. E-means can be used in automatic evidence distillation. This might be done at two levels. The first level is automatic distillation out of documents that are provided by the learner. Here, latent semantic analysis is a tool that might be useful. The other level is automatic evidence distillation out of learners actions while following a competence development programme. In this case information is extracted from stage 4 and stored to be used in stage 2. Of course, this type is only available for learners who are already enrolled in a competence development programme.
Assessment by others

Assessment by others possesses the characteristics of new types of assessment (1) involvement of multiple roles / users; (2) variety in task types; (3) complex coordination of tasks and (4) complex exchange of information. Like other new types of assessment, assessment by others requires an infrastructure that is able to provided the following support:

- support for multiple roles and users involved in the assessment processes
- support for candidates and assessors to perform various types of tasks including standard and non-standard assessment tasks
- support for complex control-flow
- support for complex data-flow (see section C3.2).

Here, learning designs come in, which enable the modeling of these four aspects of assessment by others. With respect to the multiple roles, these can be distinguished in various ways. For example, of the seven roles distinguished by the Association CH-Q, the Swiss Qualification Programme for Job Careers (Duvekot, 2005), four refer to the judgement by others: examiner, certificier and assessor. In the TenCompetence Domain model, the only relevant role is assessor. Several assessors might be involved, as is the case with 360 degrees feedback. Examples of functions that assessors should be able to perform, include: see the output that is provided by the individual in their e-portfolio; ask questions both to the learner (‘how must I interpret this piece of evidence’); ask questions to other assessors (‘how would you judge this evidence in this situation’).

C.3.1 Examples of new forms of assessment used in competence assessment

New forms of e-assessment, such as self- and peer assessment, 360 degree feedback, progress testing, and portfolio assessment, are gaining in acceptance and popularity. Such assessment types are not just 'done to' learners but are also 'done with' and 'done by' learners (Harris & Bell, 1990). By addressing complex Learner traits, these new forms aim to foster deep learning and the development of competences (Boud, Cohen, &
Sampson, 1999; Gipps, 1999; Topping, 1998). Here we describe some of these new forms of assessment in detail.

**C.3.1.1 Peer assessment**

According to (Topping, Smith, Swanson, & Elliot, 2000), peer assessment is "an arrangement for peers to consider the level, value, worth, quality or successfulness of the products or outcomes of learning of others of similar status". For the purposes of this paper, a case study is introduced that is originally described in (Orsmond, 2004). This case study describes a peer assessment exercise – writing and reviewing an article for a scientific magazine.

1. Learners are instructed how to conduct this peer assessment.
2. Each Learner selects a different paper and reads it.
3. Each Learner then prepares a brief article (400-500 words) about their chosen paper.
4. Pairs of Learners then exchange articles and review each other’s articles. The reviewer must assess the article and (i) decide whether the article is acceptable without change or whether minor/major revision is required (ii) provide specific feedback on any points raised, e.g. by writing comments on the article. Learner reviewers then return the article and evaluation sheet to the original author.
5. Each Learner writes a response to the review and may revise the article. Learners then submit documents including paper, original article, reviewed article with the reviewer’s comments, response and the final version of their article to the tutor for final assessment.
6. The tutor then marks on Learners’ exercises in a way that the quality of the original version of the article, the Learner’s response to peer review, and the Learner’s effectiveness as a peer reviewer will be considered as 30%, 30%, 40% of the overall mark, respectively.
C.3.1.2 360 degree feedback

360-degree assessment involves the assessment of an individual by a variety of stakeholders, e.g. peers, subordinates, supervisor, customers or clients (Cheetham & Chivers, 2005, p. 75). The main applications of this technique to date has been self-awareness raising, performance management and in-company development, but the technique offers a potential to be used in more formal assessment settings. Advocates argue that 360-degree assessment is fairer because it elicits perceptions of competence from people who observe an individual’s day-to-day performance from different perspectives. On the other hand, there will be difficulties in achieving consistency and commonality of understanding. Some stakeholders may have insufficient evidence of the subject’s performance. Not all stakeholders are experienced assessors. Finally, there is the danger of collusion amongst participants.

"The (360 degree) feedback process ... involves collecting perceptions about a person’s behaviour and the impact of that behaviour from the person’s boss or bosses, direct reports, colleagues, fellow members of project teams, internal and external customers, and suppliers. Other names for 360 degree feedback are multi-rater feedback, multi-source feedback, full-circle appraisal, and group performance review (Lepsinger & Lucia, 1997)." The whole process is sometimes described as having 9 steps (360-degree-feedback):

1. Determine organizational readiness for 360-degree feedback
2. Develop an appropriate survey and process given organizational needs and objectives
3. Generate enthusiasm among key decision makers and participants
4. Ensure that participants and managers have the skills to support the process
5. Provide an orientation briefing
6. Administer the survey
7. Coach participants in one-on-one meetings
8. Provide organizational summary data
9. Re-conduct the survey (in four to six months)

We describe steps 5 to 8 in more detail.

- The HR manager and employee have an orientation briefing to discuss the goals of the 360 degree feedback process and its characteristics. A document detailing the agreements made during the briefing is written by the HR manager. These arrangements cover the period in which the assessment will be carried out and the names of the individuals involved.

- A series of 10 statements which may apply to the employees behaviour (e.g. “the employee deals well with time pressure”) is sent to be completed by the employee him or herself, the employee’s direct line manager, a representative of a customer having had contact with the employee and a member of a project team in which the employee is involved. Responses to the questions are on a scale from 1 to 10 (with 10 indicating strong agreement with the statement). Raters have the opportunity to add additional remarks to motivate their rating. Each rater’s responses are stored.

- The HR manager is able to monitor which of the raters has responded and is expected to take action to prompt those who have not responded as the deadline approaches.

- The responses are accumulated and used as the basis of a review meeting. The results of the review meeting are recorded in a document which is written by the HR manager and mailed by the HR manager to the employee. This document includes a skeletal competence development plan, if needed.

C.3.1.3 Assessment centres

Assessment centres administer ‘a suite of specially designed assessment exercises to individuals in order gauge their current or potential competence’. Normally, several candidates participate in the centre at the same time since some of the exercises are group based (Cheetham & Chivers, 2005, p. 74). According to McGaghie (1993), the use of assessment centres should be expanded.
C.3.1.4 Portfolio assessment

In a broad sense, a portfolio is a purposeful collection of person’s works that presents his/her efforts, progress, and achievements, as well as demonstrates personal growth in one or more areas of the curriculum and/or job(s) over time. It is not a random collection and can be used as a very useful, beneficial and important assessment tool for teachers, employers, evaluation panels, and so on. Plus, persons (Learners/learners or employees) can use their own portfolios for self-assessment and reflection.

Portfolio assessment ranges from portfolios that demonstrate the best work to an "expanded record" that holds a full representation. Learners and/or employees are also assessed on work done together, in pairs or groups, on projects and assignments. In case of positive assessment of employee’s portfolio it can result in higher remuneration and promotion; in case of a Learner/learner – better final result or score, admission, advancing, passing learning level and so on. Portfolio should represent a collection of people's best work or best efforts, self-selected samples of work experiences related to outcomes being assessed, and documents according to growth and development toward the mastering of identified outcomes. That collection must include self-participation in selecting contents, the criteria for selection, the criteria for judging merit and evidence of Learner self-reflection (Paulson, Paulson, & Meyer, 1991).

Contents of portfolios (sometimes called "artefacts" or "evidence") can include drawings, photos, video or audio tapes, writing or other work samples, computer disks, and copies of standardized or program-specific tests. Data sources can include parents, staff, and other community members who know the participants or program, as well as the self-reflections of participants themselves. Portfolio assessment provides a practical strategy for systematically collecting and organizing such data (Sewell, Marczak, & Horn, 1998), It can consist also of teacher/employer notes, teacher/employer-completed checklists, self-reflections, group projects. In some cases, portfolios serve as a replacement for the diploma or transcript. Usually, it starts with the Table of Contents, as well as with Cover Letter summarizing the evidence of a people’s learning and progress.

Portfolios are an effective way to bring assessment into harmony with instructional goals. Portfolios can be thought of as a form of "embedded assessment"; that is, the
assessment tasks are a part of instruction. Based on the definition of the portfolio assessment and its variety of contents, the following key characteristics of portfolio assessment could be drawn:

- A portfolio is a form of assessment that Learners do together with their teachers thus providing opportunity for Learner-teacher dialogue.

- A portfolio is not just a (random) collection of someone’s work, but a purposeful one, it has clear goals and the people must be involved in choosing and justifying the pieces to be included.

- A portfolio provides samples of the someone’s work which show growth over time. By reflecting on their own learning (self-assessment), people begin to identify the strengths and weaknesses in their work. These weaknesses then become improvement goals.

- It focuses upon person’s performance-based learning experiences as well as their acquisition of key knowledge, skills, and attitudes.

- The criteria for selecting and assessing the portfolio contents must be clear to all at the outset of the process.

- It is multidimensional, i.e., reflecting a wide variety of artefacts and processes reflecting various aspects of person's learning process(es).

- A wide range of skills can be demonstrated and thus serving as a tool for assessing them.

- It enables people to show quality work, which is done without pressure and time constraints, and with the help of resources, reference materials and collaboration with others.

Some of the advantages of portfolio assessment identified in the literature are that it:

- Allows the person being assessed to be seen as an individual, each with his or her own unique set of characteristics, needs, and strengths.

- Transforms the role of the trainer away from generating comparative rankings of achievement (grades, percentile rankings, test scores) and toward
improving people’s achievement through evaluative feedback and self-reflection.

- Helps to standardize and evaluate the skills and knowledge we expect people to acquire without limiting their creativity.

- Helps people to be more accountable for the work they do and the skills and knowledge we are asking them to acquire.

- Involves individuals in the assessment process, thus giving them a more meaningful role in improving achievement.

- Invites people to reflect upon their growth and performance as learners.

- Aids in the diversification of approaches to teaching and learning, thus increasing the connections with a wider range of learners and learning styles.

- Can be used to demonstrate progress towards, and achievement of, topic or course objectives

- Focuses on higher order thinking.

Some drawbacks have also been identified:

- It may be seen by some as less reliable or fair than more quantitative or standardized evaluations such as test scores.

- Someone can often be skeptical about measurements other than grades and test scores.

- It can be time consuming, especially if portfolios are done in addition to traditional testing and grading.

- Evaluators must develop their own individualized criteria, which can be initially difficult or unfamiliar.

- Data from portfolio assessments can be difficult to analyze or aggregate, particularly over long periods of time.

- Often difficult to integrate meaningfully into various cultures where very high stakes are placed on comparative ranking and standardized tests.
- The consistency between persons is low.
- Most organisations still use test scores and grades as primary admissions criteria.

There are many different types of portfolios, each of which can serve one or more specific purposes as part of an overall assessment program. The following is a list of the types most often cited in the literature:

- **Documentation Portfolio:** This type is also known as the "working" portfolio. Specifically, this approach involves a collection of work over time showing growth and improvement reflecting person's learning of identified outcomes. The documentation portfolio can include everything from brainstorming activities to drafts to finished products. The collection becomes meaningful when specific items are selected out to focus on particular educational experiences or goals.

- **Process Portfolio:** This approach documents all facets or phases of the learning process. They are particularly useful in documenting overall learning process. It can show how people integrate specific knowledge or skills and progress towards both basic and advanced mastery. Additionally, the process portfolio inevitably emphasizes people's reflection upon their learning process, including the use of reflective journals, think logs, and related forms of metacognitive processing.

- **Showcase Portfolio:** This type of portfolio is best used for summative evaluation of mastery of key performance outcomes. It should include people's very best work, determined through a combination of individual and group selection. Only completed work should be included. In addition, this type of portfolio is especially compatible with audio-visual artefact development, including photographs, videotapes, and electronic records of person's completed work. The showcase portfolio should also include written analysis and reflections by the individual upon the decision-making process(es) used to determine which works are included.
How are portfolios assessed or evaluated? Since portfolios are qualitative, many employers find them difficult to use as a determinant of a candidate's skills. Often, employers would rather see a quantitative demonstration of a candidate's best skills and work. According to (Paulson et al., 1991, p. 63) "Portfolios offer a way of assessing learning that is different than traditional methods. Portfolio assessment provides an opportunity to observe persons in a broader context: taking risks, developing creative solutions, and learning to make judgments about their own performances."

In order for thoughtful evaluation to take place, evaluators must have multiple scoring strategies to evaluate person's progress. Criteria for a finished portfolio might include several of the following:

- Thoughtfulness (including evidence of person's monitoring of their own comprehension, metacognitive reflection, and productive habits of mind).
- Growth and development in relationship to key curriculum expectancies and indicators.
- Understanding and application of key processes.
- Completeness, correctness, and appropriateness of products and processes presented in the portfolio.
- Diversity of entries (e.g., use of multiple formats to demonstrate achievement of designated performance standards).

It is especially important to prioritize those criteria that will be used as a basis for assessing and evaluating people’s progress, both formatively (i.e., throughout an instructional time period) and summatively (i.e., as part of a culminating project, activity, or related assessment to determine the extent to which identified curricular expectancies, indicators, and standards have been achieved).

People need to identify especially significant or important artefacts and processes to be captured in the portfolio. Evaluators need to determine grades or scores to be assigned. Rubrics, rules, and scoring keys can be designed for a variety of portfolio components. In addition, letter grades might also be assigned, where appropriate. Finally, some form of oral discussion or investigation should be included as part of the summative evaluation.
process. This component should involve a panel of reviewers in a thoughtful exploration of the portfolio components, person's decision-making and evaluation processes related to artefact selection, and other relevant issues (Burke, Fogerty, & Belgrad, 1994).

**C.3.2 Requirements on an infrastructure for competence assessment**

In comparison with traditional computer assisted assessment, both judgment making and administrative processes are more problematic in competence assessments, which are process-based and involve multiple roles and multiple persons. The difficulties and the potential for errors and omissions increases in a non-linear fashion as the number of candidates and assessors involved grows (Rosbottom, 1994). As Bartram points out, 360-degree feedback by its very nature is an administrative nightmare to manage. People involved in the process tend to be geographically dispersed but also need close supervision in order to ensure that the ratings are carried out to schedule and that sufficient raters are obtained for each focus of the assessment (Bartram, 2005).

In this section, we present a number of characteristics of new forms of assessment then list a number of requirements for the TenCompetence infrastructure.

**C.3.2.1 Involvement of multiple roles/users**

New types of assessment are typically embedded in an educational context, require more stipulation of the processes of assessment and rely on higher levels of Learner involvement in assessment (Sluijsmans, Brand-Gruwel, van Merriënboer, & Martens, 2004). In work settings, many people with various roles may be engaged in the assessment processes. For example, in peer assessment, two Learners and one tutor are involved in the assessment process. The Learners have both candidate role and assessor (rater) role. In the 360 degree feedback process, multiple people with different roles such as HR manager, line manager, fellow members of project teams, and customers are engaged in the assessment process.

**C.3.2.2 Variety in task types**

Various types of tasks will be performed in assessment processes. On the one hand, tasks are arranged for candidates to demonstrate their progress and capabilities such as answering a questionnaire, writing an article, providing a portfolio, conducting a performance, and so on. On the other hand, certain types of tasks will be performed by
assessors for describing, collecting, recording, scoring, and interpreting information about Learners’ learning. The types of tasks required to be performed depends on the nature of the trait to be assessed.

In the case study of peer assessment, each Learner provides evidence by writing a brief article. At the next step, each Learner assesses the article of his peer Learner in a way to answer two questions. The first one is a multiple-choice question with three options: 1). the article is acceptable without any change, 2). the article is acceptable with minor/major revision, 3). the article is unacceptable. The second question is an open-question that is used for writing comments. In the case study of the 360 degree feedback process, a series of, for example, 10 slider items (each with 10 scales) is used for indicating the degree of agreements with the statements.

In order to assess a competence that may not be directly measurable, a complex trait is usually decomposed into several lower level traits that may be decomposable further into elementary traits, called simple traits (Brinke et al.). For assessing a simple trait a specific item can be used. Thus, an assessment for assessing a complex trait consists of a set of items with certain composition rules and the assessment criteria and rules.

Sometimes, simple and pre-set standard items and even structured assessment are not sufficient to assess certain competences. Many simulation tools and domain-specific application tools may be more suitable for assessing certain generic or specific competences. (Pellegrino, Chudowsky, & Glaser, 2001) provide several examples, such as the use of concept mapping to assess knowledge structures, or the use of latent semantic analysis to interpret Learner essays. In principle, any well-developed application tool to support carrying out a certain task can be potentially used as an assessment tool. When a user carries out a task by using an application tool, the user’s performance can be observed or captured for assessment. These application tools are called specific assessment tools which can be used to support specific assessment tasks.

C.3.2.3 Complex coordination of tasks

In innovative assessment processes, various tasks are carried out by many participants with different roles in sequence or in parallel. The termination of one task may trigger the start of another task. For example, in peer assessment, two Learners and one tutor carried
out a structured process with six phases. In each phase they focus on a certain type of task, and have to coordinate their activities. In the 360 degree feedback process, the core assessment process consists of five phases. Tasks in different phases are carried out by people with different roles in sequence and in parallel. Highly structured peer assessment formats are also reported in literature. In Reciprocal Peer Tutoring, Learners are paired and in a structured manner take turns acting as a tutor and tutee (Fantuzzo, Dimeff, & Fox, 1989).

**C.3.2.4 Exchange of information**

In new forms of assessment, a large quantity of information is produced by participants in performing various tasks in different phases. The data must be transferred to the right persons at the right time. People with different roles interact with each other through the exchange of information. In the peer assessment example, peer Learners exchange their articles and then exchange their reviews. Finally, they send all data including responses on their peers’ feedback to the tutor. In the case study of 360 degree feedback, the HR manager send a questionnaire to the employee, the employee’s direct line manager, customers and project team members and then collect all feedback from them. From these characteristics, we can derive the following requirements for an infrastructure for competence assessment:

- Support for multiple roles and users involved in the assessment processes,
- Support for candidates and assessors to perform various types of tasks including standard and non-standard assessment tasks,
- Support for complex control-flow
- Support for complex data-flow.

With these high level requirements in mind, we can derive some specific use cases for the TenCompetence assessment infrastructure.
C.3.3 Use cases for a competence assessment infrastructure

C.3.3.1 Assessment Design Use Cases

Create New Assessment Scenario

<table>
<thead>
<tr>
<th>Description</th>
<th>This use case describes the process of creating new Assessment Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary Actors</td>
<td>Assessment_Author, Instructor</td>
</tr>
</tbody>
</table>
| Basic Flow | 1. The user logs into the system as Assessment_Author or Instructor.  
2. The User specifies settings for Assessment Scenario (order, weight, isRequired and scenarioRule).  
3. The User specifies Assessment Session settings (date, start and end).  
4. The User saves the Assessment in Repository Bank.  
5. The user logs out of the system. |
| Alternative Flow | None |
| Pre-Conditions | The User has rights for creation of Assessment Design |
| Post-Conditions | None |
| Specific Requirements | None |
| Include | None |
**Create New Assessment Plan**

<table>
<thead>
<tr>
<th>Description</th>
<th>This use case describes the process of creating new Assessment Plan.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary Actors</td>
<td>Assessment_Author, Instructor</td>
</tr>
</tbody>
</table>
| Basic Flow | 1. The user logs into the system as Assessment_Author or Instructor.  
2. The User specifies settings for Assessment Decision Rule.  
3. The User specifies Assessment Scenario, using one of the offered.  
4. The User specifies Traits for current Assessment Plan, using one of the offered.  
5. The User specifies Assessment Police, using one of the offered.  
6. The User saves the Assessment Plan in Repository Bank.  
7. The user logs out of the system. |

| Alternative Flow | None |
| Pre-Conditions | The User has rights for creation of Assessment Design. |
| Post-Conditions | None |
| Specific Requirements | None |
| Include | None |

**C.3.3.2 Item Construction Use Cases**

**Create New Item**

<table>
<thead>
<tr>
<th>Description</th>
<th>This use-case describes the process of creating new Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary Actors</td>
<td>Assessment_Author, Instructor</td>
</tr>
</tbody>
</table>
### Basic Flow

1. The user logs into the system as Assessment_Author or Instructor.
2. The System displays the following list of item-types.
3. The User chooses one of the offered types.
4. The system offers the User to input the Case Text to be presented to the Learner.
5. The User inputs the Case Text.
6. The system offers the user to describe (the set of) possible responses according to the chosen Response-type.
7. The user describes the possible responses and defines the right and wrong responses.
8. The system offers the user to choose the appropriate Rendering-type for the Item.
9. The User chooses one of the Rendering-types.
10. The System offers the User to input Hints for the Item.
11. The User inputs Hints.
12. The System offers the User to input Feedback.
13. The User inputs the information to be presented to the Learner in case of choosing right or wrong answers.
14. The System offers the User to input Prompt for the Item.
15. The User inputs Prompt.
16. The System offers to input metadata information for this Item (QTI metadata specific information).
17. The User inputs the QTI metadata specific information about this Item. This information is necessary when searching the Item in repository bank.
18. The System offers the User to view the constructed Item.
19. The System offers the User to save the Item.
20. If saving is successful the System displays message “Item saved successfully. Do you want to create another Item? Yes/No”.

### Alternative Flow

- **Alternative Flow of Events:**
  - On the Step 4 the User could set specific material attributes if necessary: type of the material (text, graphics, audio, video, etc), file location, etc.
- **Alternative Flow of Events:**
  - After Step 8 the User could choose to skip any of the Steps 9-14.
- **Alternative Flow of Events:**
  - On every step the User could require Help information.
- **Alternative Flow of Events:**
  - After step 18 if user chooses “Yes” the system goes to step 2.
- **Alternative Flow of Events:**
  - After step 18 if user chooses “No” the system logs out the user.
- **Error/Exception Flow of Events:**
  - On Step 16 if the Item hasn’t been saved in the Repository
**Edit Item**

**Description**
This use case describes the process of modifying existing Item, retrieved from a repository bank.

**Exemplary Actors**
Assessment_Author, Instructor

**Basic Flow**
1. The user logs into the system as Assessment_Author/Instructor
2. The system offers a form with fields representing all Item properties
3. The User fills the fields with desired information about the searched Item.
4. The User submits the forms by pushing a Submit button.
5. The System searches Repository bank and retrieves Item (set of Items) that matches the described criteria.
6. The User chooses one Item and modifies desired properties (including QTI metadata information).
7. The User saves modification by pushing the Save button.
8. The system saves the Item in Repository bank as new element.
9. If saving is successful the System displays message “Item saved successfully”.

**Alternative Flow**
- *Alternative Flow of Events:*
  After Step 2 the User could choose to clear the form by pushing Reset button.
- *Alternative Flow of Events:*
  After Step 5 the User could choose to exit without saving by pushing the Cancel button. The System returns the User to Step 1.
- *Error/Exception Flow of Events:*
  On Step 8 if the Item hasn’t been saved in the Repository bank the System displays message “Error: The Item is not saved due to…”.

<table>
<thead>
<tr>
<th>Pre-Conditions</th>
<th>The User has rights for creation of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Conditions</td>
<td>None</td>
</tr>
<tr>
<td>Specific Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Include</td>
<td>None</td>
</tr>
</tbody>
</table>
| Open Issues | - For next versions – Hints could be presented in different media formats (in this version only text is allowed).
- For next versions – Feedback could be presented in different media formats (in this version only text is allowed). |
| Pre-Conditions       | 1. The User has rights for modification of Items.  
|                      | 2. At least one item must exist in repository bank. |
| Post-Conditions      | None |
| Specific Requirements| None |
| Include              | None |

### Delete Item

| Description | This use case describes the process of deleting Items from Repository Bank. |
| Exemplary Actors | Assessment_Author, Instructor |
| Basic Flow | 1. The User logs into the system.  
|            | 2. The system displays a list with the Items.  
|            | 3. The system displays a form with fields that represent properties of the chosen type of element.  
|            | 4. The User chooses the desired element and pushes the button “Delete”.  
|            | 5. The system checks if the user has rights to delete this element. If it is true the system deletes it from Repository Bank.  
|            | 6. The User logs out of the system. |
| Alternative Flow | *Alternative Flow of Events:*  
|                  | On step 3 apply steps 2-5 from Modify Item Use Case.  
|                  | *Alternative Flow of Events:*  
|                  | After step 6 if the user doesn’t have rights to delete this element, the system displays a message “Sorry, you don’t have right to delete this element” and returns to step 2. |

| Pre-Conditions | 1. The User has rights for modification of Items.  
|                | 2. At least one item must exist in repository bank. |
| Post-Conditions| None |
| Specific Requirements| None |
| Include         | None |

### C.3.3.3 Assessment Construction Use Cases
Create New Unit of Assessment

**Description**
This use case describes the process of creating new Create New Unit of Assessment of existing Items and Assessment Plan from Repository Bank.

**Exemplary Actors**
Assessment_Author, Instructor

**Basic Flow**
1. The User logs into the System.
2. The System displays a form with fields that present specific information for element Assessment Plan.
3. The User specifies desired fields and submits the query by pushing the Submit button.
4. The System searches Repository Bank and retrieves set of Assessment Plans that match specified criteria.
5. The User selects the desired Assessment Plan.
6. The System displays set of Items based of selected Assessment Plan.
7. The User selects the desired Items, using one of the offered algorithms for selection (All, Parameterized All, Partial, and Parameterized Partial).
8. The User specifies settings for Unit of Assessment (title, estimatedDuration, maximumDuration, blueprint, compositionRules, minPersons, maxPersons, presentationMedia, candidateRole, candidateInstruction, computeFinalScore).
9. The User specifies algorithms for scoring, using one of the offered Scale.
10. The User saves specified Unit of Assessment.
11. The user logs out of the system.

**Alternative**
None
C.3.3.4 Assessment Run & Response Processing Use Cases

**Browse Performed Assessments**

**Description**
This is the main use-case used by Assessment_Author or Instructor for work with already given to Learners Assessments. He/she uses it for control and monitoring of Learners’ assessment performance.

**Exemplary Actors**
Assessment_Author, Instructor

**Basic Flow**
1. The Actor sends a request to system for generating the list of assessments.
2. The system generates a list of assessments according to Actor’s Rights:
   a. User can view results of these assessments.
   b. Assessments are opened (or activated) by this moment.
   c. Assessments are fully evaluated and closed.
   d. These characteristics of any assessment are displayed in list by check marks or availability of buttons <View> and

---

Flow

<table>
<thead>
<tr>
<th>Pre-Conditions</th>
<th>The User has rights for creation of Create New Unit of Assessment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Conditions</td>
<td>None</td>
</tr>
<tr>
<td>Specific Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Include</td>
<td>None</td>
</tr>
</tbody>
</table>
3. The Actor selects one of listed assessments.

<table>
<thead>
<tr>
<th>Alternative Flow</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Flow of Events:</strong></td>
<td>User decides to Evaluate selected assessments.</td>
<td></td>
</tr>
<tr>
<td><strong>Alternative Flow of Events:</strong></td>
<td>Instructor decides to View evaluated assessment.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre-Conditions</th>
<th>1. User is correctly logged into system.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. There must be at least one assessment given to Learners.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Post-Conditions | Normally status of assessment (from not Evaluated to evaluated), evaluation of any response, or evaluation rules for a particular assessment must be changed, but not this is not obligatory post condition. |  |

| Specific Requirements | None |  |
| Include | None |  |
Perform Assessment

**Requirements**

| Include | None |

**Description**

By this use case user can perform selected assessment

**Exemplary Actors**

Learner

**Basic Flow**

1. The actor answers items in Unit of Assessment.
2. The answers are recorded by the system in Item Response.
3. The user finalizes test.

**Alternative Flow**

- *Alternative Flow of Events:*
  The user can cancel assessment during testing process. Information about this is stored in the system.
- *Alternative Flow of Events:*
  Assessment that is interrupted or not finished by the Actor can be continued later on some conditions.

**Pre-Conditions**

1. The user is logged to the system.
2. The assessment must be selected.

**Post-Conditions**

Instructor must be informed about test taken by the learner.

**Specific Requirements**

None

**Include**

None

---

**C.4 Review of existing specifications**

**C.4.1 The IMS QTI specification**

The leading specification for the exchange and interoperability of assessments is the Question and Test Interoperability specification (IMSQTI, 2006). The primary goal of this specification is to enable the exchange of questions (called ‘Items’) and tests (called ‘Assessments’) between Learning Management Systems. The Question and Test Interoperability specification describes questions and tests by (a) providing a well documented content format for storing items independent of the authoring tools that were used to create them; (b) supporting the deployment of items and item banks across a wide
range of learning and assessment delivery systems and (c) enabling systems to report results in a consistent manner (Joosten-ten Brinke, Gorissen, & Latour, 2005).

The QTI interoperability information model is based on the four-process framework (Almond, Steinberg, & Mislevy, 2001). The authors discuss the relationships between the functions and responsibilities of the processes and the objects in the QTI information model. The QTI specification is limited to those assessment types for which an unambiguous definition in technical terms can be specified. Examples of these assessment types are multiple choice items, open-ended questions, matching items. The simple structure of these items makes them well-suited for storage in item bank systems and delivery in digital format. The QTI specification supports the exchange of items in standardized assessments. Test developers in an educational program may use colleagues’ multiple-choice items. For example, items about ‘knowledge of the learner’ in teacher education developed at university X will match with the educational program of teacher education in university Y. The test developer who wants to use these items has to ensure that these items match, based on learning objectives, their wording and format. Often these multiple-choice items are stored in item bank systems. By using a specification such as QTI to code them, these items may be exchanged between different platforms and presented in various formats to Learners. The structure of the items must be comprehensive with regard to the domain to make them useful for domain specialists.

The implementation of the full QTI specification has proven to be difficult. In a review of software applications that claim to support QTI, Gorissen (2003) found that in almost all cases the support was restricted to the item layer, leaving the Assessment and Section layer aside. The latest version of the QTI specification is a minor upgrade that provides additional features on the Assessment and Section level. This may enhance the storage and exchange of complete tests with a strong focus on computer-based assessment, but does not provide a solution for new types of assessment like portfolio assessment or peer assessment.
C.4.2 Combining IMS LD and IMS QTI to support new forms of e-assessment

IMS QTI can not be used to model process-based, multi-user assessments. IMS Learning Design (IMSLD, 2003) can be used to model learning processes with complicated process-control and multiple roles/users. However, assessment tools and strategies are not explicitly included in IMS LD, although these can be included by reference to content elements that are assessments (IMSLD, 2003). The combination of IMS LD, IMS QTI, and specific assessment services can be used to model and deliver new forms of assessment targeting competence development. The main benefit of this approach is that existing specifications, tools and services can be used to model and deliver integrated learning designs with innovative assessments. Furthermore, reuse of such integrated learning designs and innovative assessments becomes possible together with their delivery in different platforms. In this way, new forms of assessment can be modelled as a unit of assessment, a specific unit of learning referring to QTI documents and/or specific assessment services.

- Supporting multi-role/user-involved assessment processes. IMS QTI specification is concerned with individual learners. Although IMS QTI does not prohibit usage in contexts involving other actors (e.g., instructors, supervisors, and peers), it does not support explicitly defining other roles or sequencing behaviours that result from participation of other actors. IMS LD can support a multi-role/user teaching-learning process. In IMS LD, two primary roles (learner and staff) are defined. Each role can have sub-roles defined by designers to fit the context of the learning design.

- Supporting a variety of assessment tasks. The IMS QTI item types include open-question, multiple choice/response, fill-in-blank, hotspot, match, drag&drop, and so on. It also provides sufficient flexibility to grow into the advanced constructed-response items and interactive tasks we envisage as the future of assessment elaborates the assessment items in detail (Almond et al., 2001). Furthermore, it provides mechanisms to design structured assessment and control branches and calculate weighted scores. That is, all standard
assessment tasks and structured assessment that form the core subset of current practice can be supported by using IMS QTI tools. IMS LD offers an approach to integrating application tools as services. Although only four services are specified in IMS LD, in theory, any software tool can be integrated in a learning design as an external service. Therefore, with an appropriate interface, any specific assessment tool (e.g., a portfolio editor, a concept-mapping, and a simulator) can be integrated into a unit of assessment.

- *Supporting complicated control-flow.* IMS LD can support the modelling of a learning flow with complicated process controls. Activities can be arranged as a sequence or a selection structure. A set of role-parts can be performed in parallel within an act and acts within a play will be carried out in sequence. Multiple plays can be executed as concurrent threads. The termination of a task may trigger the start of another task according the definition. In addition, conditions and notifications provide more powerful mechanisms to control the process. The support provided at IMS LD level B and level C makes it possible to trigger the start and termination of tasks in a data-driven manner as well. Considering the complexities of new forms of assessment in process control, IMS LD has sufficient expressiveness to model the complicated control-flow in new forms of assessment.

- *Supporting complicated dataflow.* IMS QTI provides mechanisms for declaring outcomes. The outcome of an item a section, or a test can be processed as the output of an assessment. IMS QTI version 2 specifies how an outcome variable of IMS QTI can be coupled to an IMS LD property. With the help of this mechanism, an item response and an assessment score can be transferred to relevant participants. That is, the data produced by a participant (e.g., a candidate) can be presented to another one (e.g., an assessor). Additionally, scores given by all assessors can be processed according a certain rule into a collective (aggregated) result. This result can be transferred to a candidate or even can be used to control the branching.
In order to understand the degree to which today’s e-learning infrastructure can support new forms of assessment, we examine two implemented examples: peer assessment and 360 degrees feedback. Figure 15 illustrates a process model for an example of peer assessment taken from (Orsmond, 2004).

- **Modelling roles.** In the peer assessment example there are two kinds of roles: tutor and learner. In order to explicitly model the tasks of each peer Learner and the exchange of information between them, learner1 and learner2 are defined as two sub-roles of the learner. The maximum and minimum number for each role has been restricted to one. This means that in the population phase each role has to be assigned to one and only one person.
- **Modelling tasks.** Participants with different roles are assigned to do different tasks. The tasks are modelled as learning activities (e.g., selecting/reading paper1 and responding review1) and support activities (e.g., final assessment1) in the model. Each activity has an element called activity-description, some of which (e.g., writing article1 or reviewing article2) refer to QTI documents.

- **Modelling control-flow.** The overall assessment process is defined as a play with six acts illustrated in the Fig. 1. Each act consists of more than one role-part. Such a relationship is represented in Fig. 1 as a box contains several rounded rectangles. In the first act, the tutor teaches learners how to conduct this peer assessment and what is expected. In the second act, two peer Learners select a different paper respectively and read the selected papers. In the third act each Learner writes an article. In the fourth act Learners review the articles of their peers and comment on them. In the following act they response to the reviews of their peers and revise the original article if necessary. In the last act, the tutor assesses the Learners’ work and give them scores. All acts are executed in sequence. The arrows with solid lines in Fig. 1 indicate the control-flows of the process. For synchronizing activities, a check-point can be defined as a complete-act condition of an act (e.g., selecting/reading-articles). The complete-act condition specifies if and only if both Learners finish their tasks within an act, the act will be terminated and the following act will start. This is a kind of task-driven process control mechanism.

- **Modelling data-flow.** Data are represented in IMS LD as properties. A property can be used to record the outcome of the participant (e.g., article1 and review1) or to capture the current state of the process (e.g., are-articles-submitted). As we see in Fig. 15, data (e.g., article1, article2, review1, review2, and so on) are produced by a learner in an activity and will be used by another learner in another activity. The arrows with dash lines indicate the data-flows in the process. Viewing the value of a property is realized by using “view-property” element in a XHTML document, which is modelled as a learning resource and will be referred to by an item. The item is defined in a learning object within an
environment. We define two environments for storing data regarding to the work of two learners, respectively. For example, environment1 will be associated with all activities handling article 1 such as selecting/reading paper1, writing article1, reviewing article1, responding review1, and final assessment1. Since all data concerning article1 is collected in this environment, this shared environment can be used by learner1 writing article1, by learner2 reviewing article1, and by tutor assessing learner1’work.

This example can be executed fully in CopperCore with the Apis IMS QTI service (APIS, 2004; Vogten et al., 2006). Figure 16 shows a screenshot of the user interface when learner1 is reviewing article 2.

![Figure 16: A screenshot of the execution of the peer assessment example](image)

The 360 degree feedback process “involves collecting perceptions about a person’s behaviour and the impact of that behaviour from the person’s boss or bosses, direct reports, colleagues, fellow members of project teams, internal and external customers, and suppliers” (Lepsinger & Lucia, 1997). Figure 17 shows a process model for an example of 360 feedback.
In this model, the employee is defined as a sub-role of the learner. The other four roles are defined as sub-roles of staff. Three acts are defined: preparation, assessment, and report. In the preparation act, the HR manager discusses with the employee and then works out an agreement. In the assessment act, role-parts are defined to assign tasks to line manager, project members, customers, and employee himself. Each participant of these role-parts will provide feedback. In the final act, the HR manager will discuss the feedback with the employee and write an assessment report. In the first act and the third act, as illustrated in Fig. 3, the HR manager is assigned to do two sequential activities connected with an arrow. What is different from the first example is the type of items used to rate the employee. These items are defined using a QTI slider type.

The combination of IMS LD and IMS QTI has three primary advantages:

- Support for interoperability. Existing software tools for new forms of assessment have been developed and used as standalone application tools. They have their own data representation that is not usable by other applications. Their
functions cannot be shared directly by other software. In contrast, our approach is based on international e-learning technical specifications. A unit of assessment can be executed in any IMS LD player with any integrated IMS QTI player. The components of a unit of assessment or the unit as a whole can be stored, retrieved, and adjusted for reusing and improving in different context and in different learning platforms.

- **Support for Flexibility.** Each new form of assessment may vary in a number of variables. For example, in peer assessment the variables could include levels of time on task, engagement, and practice, coupled with a greater sense of accountability and responsibility (Topping et al., 2000). Software may support flexibility to a limited extent. However, once software has been developed, it is difficult to change to fit changing learning contexts and specific needs. In particular, if a certain domain-specific simulation tool is needed as a specific assessment tool, it will be very difficult for existing assessment software tools to extend their functions. However, by adopting our approach, we can easily modify the definitions of components and their relations in a learning design (e.g., learning activities, assessment activities, their sequence, referred learning objects and assessment items, integrated specific assessment services, and so on). Learning designers can develop their customized units of assessment with less effort and time.

- **Support for seamless integration with learning processes.** Existing software tools for supporting new forms of assessment can be used for formative assessment and summative assessment. However, the learning activities to be integrated are conducted either in a face-to-face learning environment or in a content-centred e-learning environment. In both situations, the integration between learning activities and assessment are manually implemented. That is, the users have to manually shift learning environments or application tools for performing learning activities and for conducting assessment tasks. Our approach is based on IMS LD that can formally describe a wide range of pedagogical approaches. If learning activities are also represented in IMS LD,
there will be a seamless integration between the learning activities and new forms of assessment, since both are be specified within the same unit of learning. For example, if an e-assessment is arranged as a formative assessment, the assessment results defined as outcome variables in IMS QTI can be used by IMS LD engine as properties to choose appropriate following-up activities for each user according to his/her role, personal characteristics, assessment results, and so on. The shift from generic assessment services and specific assessment services to learning management systems is transparent for users when they shift from conducting assessment tasks to performing learning activities.

However, some limitations can be identified:

- The required level of technical knowledge of IMS LD and IMS QTI for those authoring assessments is significant. Currently, the editing and debugging tools for specifying a learning design offer only a limited degree of support.

- Part of this difficulty lies in a representational mismatch between the concepts offered by IMS LD and IMS QTI and the world of assessment experts. Extensive use of properties, variables and conditions leads to opaque units of assessment not easily reviewed and understood.

- Furthermore, not all aspects of the assessment process can be represented using IMS LD and IMS QTI. The decision associated with an assessment, the learner characteristics which are the subject of assessment, the population being assessed and other “meta” aspects of the assessment process require the use of additional representational constructs.

These points lead to the need within TenCompetence to augment today’s open technical specifications with additional modelling concepts, leading to a formal, integrative specification model.

**C.5 The TenCompetence assessment specification**

The TenCompetence work on support for competence assessment draws on existing work known as the OUNL/CITO assessment model. We first present this model, then
describe simplifications identified which lead to the TenCompetence assessment specification.

**C.5.1 The OUNL/CITO Assessment Model**


We define assessment as all the systematic methods that can be used to gather information and evidence about Learner properties, based on a process, a product or the progress of a Learner, for the purposes of certification, placement or diagnoses in formative and summative contexts. This definition includes classical tests, examinations and questionnaires, as well as newer types of assessment, such as performance assessment, portfolio assessment and peer assessment.

New types of assessment are typically embedded in an educational context, require more stipulation of the processes of assessment and rely on higher levels of Learner involvement in assessment (Sluijsmans et al., 2004). New assessment types have great potential, but problems in terms of quality criteria and resources as well. The assessment developers have to cope with quality criteria, like authenticity, meaningfulness, fairness and educational consequences (for a full description of assessment quality criteria for competence assessment, see (Liesbeth K.J. Baartman et al., 2004) and the development of reliable and valid assessments is time-consuming and expensive.

Although technological improvements such as today’s open technical specifications help to promote re-use and exchange of assessments, assessment developers must also share the same conceptual framework of the assessment domain to understand what can be re-used or exchanged. Pellegrino, Chudowski and Glaser (2001) describe initiatives on the assessment of competences based on insights into how people learn and how knowledge and knowledge structures develop. The authors define a new framework for assessment based on the assessment triangle of ‘cognition’, ‘observation’ and ‘interpretation’. Here, cognition is a model of how a learner represents knowledge and develops competencies; Observations are tasks or situations in which (complex)
behaviour can be observed, and interpretation is a means by which one can make sense of the observations. Pellegrino et al. provide several examples of new linkages, such as the use of concept mapping to assess knowledge structures (linking cognition to observation), or the use of latent semantic analysis to interpret Learner essays (linking observation to interpretation). In this framework items (tasks) provide part of the evidence that is linked to the learning objective and they must support decisions that are based on the assessment results. The items that are selected for observation should be developed with the purpose of the assessment in mind (i.e. going from cognition to observation). The evidence gathered still needs to be interpreted. This interpretation makes clear how the collected observations constitute evidence about the learner’s competencies.

An important consequence of the new foundations of assessment seems to be that any exchange of assessment has to include all three points of the triangle, rather than being limited to the exchange of the test items. This raises several questions: Can all the assessment aspects (cognition, observation, interpretation) be described using specifications as the ones mentioned above? Or need these specifications be extended? Can all assessments be re-used completely, and if not, what isolated parts of assessment can be re-used? Can we describe all sorts of tasks and situations, or are we limited to particular formats such as multiple-choice items?

In the conceptual assessment framework of Almond, Steinberg and Mislevy (2001; 2003) assessment is viewed as a process in which an administrator, who is responsible for setting up and maintaining the assessment, and a candidate, whose traits are being assessed, are actors in a system. The framework promotes reusability of both objects and processes and can thus provide a start in answering our questions. But there are some limitations to the model. It is developed with computer-based assessment in mind and it is focused on the execution phase of an assessment. The limitation of the QTI specification for assessment interoperability is that it is concentrating on the ‘observation’ point of the assessment triangle, where it offers support to rather traditional tasks. To include the other vertices a more encompassing model is needed. Such a model should meet the general requirements of an educational model (derived from (Koper, 2001)).
1. **Flexibility**: The assessment model can describe assessments that are based on different theories and models.

2. **Formalization**: The assessment model describes assessments and its processes in such a formal way that it is machine-readable and automatic processing is possible. The formalization gives the possibility to extend the model if new developments in assessment arise.

3. **Reusability**: The assessment model supports identification, isolation, de-contextualization and exchange of useful objects (e.g. items, assessment units, competencies, assessment plans) and their re-use in other contexts.

4. **Interoperability and sustainability**: The assessment model distinguishes the description standards from the interpretation techniques, thus making the model resistant to technical changes and conversion problems.

5. **Completeness**: The assessment model covers the whole assessment process, including all the typed objects, the relations between the objects and the workflow.

6. **Explicitly typed objects**: The assessment model expresses the semantic meaning of different objects within the context of an assessment.

7. **Reproducibility**: The assessment model describes assessments in such a way that replicated execution is possible.

8. **Medium neutrality**: The educational model for assessment, where possible, supports the use of different media, in different (publication) formats, such as computerized assessments on the web or paper and pencil tests.

9. **Compatibility**: The assessment model matches available standards and specifications.

The OUNL/CITO model is an extensible educational model for assessment which provides a broader basis for interoperability specifications for the whole assessment process from construction to evaluation. The model allows a tight embedding of assessments in educational practice and it caters for new types of observation and
interpretation. The model is built on several sub-models, each matching a different stage in the assessment process as depicted in Figure 18. In the assessment design the objectives for the assessment are clarified. Decisions in this stage influence the elaboration of the next stages.

**Figure 18: The stages in the assessment process**

**C.5.1.1 Assessment design**

The reasons for using assessments are expressed in the stage of assessment design. The challenge in assessment design is to select the assessment types that yield the appropriate evidence of Learners’ competence, skills or knowledge. A competence assessment, for example, can consist of a portfolio assessment, that provides a measure of individual growth with respect to individual goals, in combination with a multiple-choice exam that provides a measure of knowledge acquisition. Both assessment measures are important providers of information of Learner traits and both can be used in a competence assessment. The concepts and their relations in assessment design are represented in Figure 19.
Figure 19: Assessment design: class diagram of the concepts and their relations.

The assessment policy of an educational institute is the basis for the development of an assessment (Van Zutven, Polderdijk, & De Volder, 2004). This framework enumerates assessment types that are allowed according to the policy of the institute. Within the scope of this assessment policy one or more assessment plans can be designed. An assessment plan includes the basic assumptions for an assessment. An example of an assessment plan is an assessment to measure writing skills. The plan stipulates the decision rules that set down how a decision maker will come to a decision on a candidate. The assessment function in the assessment plan stipulates the purpose of the decision. Assessment functions include diagnosis of individual candidates, formation of groups, selection or certification. The assessment plan addresses one specific population. The assessment plan prescribes which assessment types can be used for units of assessment. These must be assessment types that match the assessment policy of the institute. The assessment scenario is part of the assessment plan. An assessment scenario determines the mandatory and optional units of assessment for a candidate, as well as their sequence and time.
schedule. The units of assessment are described in the unit of assessment definition. The last, but very important part of the assessment plan is the trait. This is the abstract concept of the characteristics of the candidate on which decisions will be taken. These traits are important for educational contexts because they give the criteria for education in terms of level and direction. A trait is determined in advance for the population for which the assessment plan is set up and it can be decomposed into complex traits and elementary traits.

**C.5.1.2 Item construction**

The model of the concepts and their relations in item construction are represented in Figure 20. The main concept in this stage is the item.

![Figure 20: Item construction: class diagram of the concepts and their relations.](image)

In this stage the concepts elementary trait and population that were described in the previous stage are the guiding lines for the construction of items. Indicators measure the elementary trait. Often, however, direct observation of a characteristic of a Learner (trait) is not possible. For example, by observing a teacher in the classroom we cannot directly measure whether the teacher understands how Learners learn. To that end, indicators are specified that provide evidence on the trait. These indicators are measurable descriptions...
of the trait. A score on an assessment has a meaning for a trait, but it is directly based on scores on the underlying indicators by applying a calculation rule on the scores. For every indicator items can be developed that are suitable for the population to which the assessment plan applies. The term Item in this model has to be interpreted in a broad sense. For example, it applies to a multiple-choice item with four answering options, as well as to a task in which a candidate has to show a performance.

Candidates can provide answers in a number of formats, such as a construction, a selection out of response possibilities, or the demonstration of a skill. These item types are named construction item, selection item and demonstration item. An item usually has a prompt, a case text, hints and feedback. The prompt is the explicit message to the candidate that makes clear what is expected (within the item) of the candidate. In unannounced workplace observations it is possible that the prompt is not given. The case text is a description of a context in which the item has to be made. Hints and feedback are both instruments to give the Learner supportive information, the hint beforehand, and feedback afterwards. For all relevant indicators an item must have a rating instruction. The rating instruction specifies for each item the characteristics of a correct answer in relation to the indicator.

C.5.1.3 Assessment construction
The third stage is that of assessment construction. The model of the concepts and their relations in this stage are presented in Figure 21.
The central concept in this stage is the unit of assessment. This is a composite of items that will be presented to a candidate based on a unit of assessment definition. In this definition the composition rules describes the structure of the assessment. Composition rules may be used in advance to generate an assessment, as well as dynamic during assessment sessions to select new items, for instance in adaptive assessment. The assessment type of a unit of assessment are restrained to the types that were defined in the assessment plan. The characteristics of a unit of assessment definition are the session time, the number of candidates that may participate, the way the unit of assessment is presented to the candidate, the possible roles the candidates have to fulfill in the unit of assessment and several rules. These rules are about the composition of the assessment, rules prescribing what items may be used and in what order and rules that specify how the final score on a unit of assessment will be calculated. The definition defines which
trait will be assessed in a specific unit of assessment (unit of assessment trait) and which indicators are used to this purpose (unit of assessment indicator). The items used in a unit of assessment are selected because they measure a specific indicator. They might measure other indicators as well, but that is irrelevant in the context of this unit of assessment. Therefore the assessment item is defined for a specific item in a specific unit of assessment. The assessment item indicator gives the specific indicator that is meant to be measured with this item. The scale prescribes which values can be given to the assessment item indicator.

C.5.1.4 Assessment run

As soon as the unit of assessment is composed, the assessment can be delivered to the candidates. The model of the concepts and their relations in this assessment run stage are represented in Figure 22. The central concept in this stage is the session.

![Figure 22: Assessment run: class diagram of the concepts and their relations.](image)

Depending on the kind of assessment, a candidate must provide responses, or demonstrate or present something to an assessor. Units of assessment are presented to candidates, who can be individual persons or groups. The actual presentation of one or more units of assessment to the candidates is done during assessment sessions. Each session has a date, a starting time and a stop time. During this session each candidate has
an assessment take which specifies the medium in which the unit of assessment is presented, as well as the available candidate roles. The output of a session are item responses. An item response can be an answer to a question, a performance or a report.

**C.5.1.5 Response rating**

The next stage is that of response rating. The model of the concepts and their relations in this so-called assessment run stage are presented in Figure 23.

![Figure 23: Response processing: class diagram of the concepts and their relations.](image)

After an assessment take an assessor must assess the item responses. The assessor can be a computer, a teacher, peer candidates or even the candidate. The assessor provides a rubric score that addresses the assessment item indicators. To do so the assessor uses transformation rules to get from a rubric value to a rubric score, to an assessment indicator score and to a trait score. The assessment indicator score addresses the unit of
assessment indicator, while the trait score addresses the unit of assessment trait, the scoring prescription and a scoring instruction.

**C.5.1.6 Decision making**

The last stage is that of decision making. The model of the concepts and their relations in this assessment run stage are represented in Figure 24.

![Decision making: class diagram of the concepts and their relations.](image)

**Figure 24: Decision making: class diagram of the concepts and their relations.**

At the end of the process a decision must be made that is based on the score of a candidate on a certain assessment take. The kind of decisions that can be made are described in the assessment plan (see assessment design stage). Often, the person who makes the decision is a teacher, but in general, this is the institute where the candidate is enrolled. The decision is based on decision rules.

One area to be addressed in the current model is the lack of statistical and psychometric information, which is often formulated in several rules. For the structure rules between assessment scenario and unit of assessment, an example of more detailed modelling is depicted in Figure 25.
Figure 25: Assessment plan, assessment scenario and unit of assessment modelled in more depth
C.5.2 The TenCompetence assessment specification

Two reasons lie behind the simplification of the OUNL/CITO model for use in TenCompetence:

- The OUNL/CITO model is extensive and complex, aiming for completeness in its coverage of all forms of assessment. This complexity has an impact on the usability of the model and a simplification could increase the adoption of its concepts.

- The TenCompetence Domain Model provides a larger framework into which the assessment model must be dovetailed. Some duplication of concepts is apparent in the two separate models, which could be removed through harmonisation.

C.5.2.1 A comparison between the two models

The TenCompetence assessment specification was developed by implementing a number of simplifications in the OUNL - CITO model. These simplifications include the removal of one stage and of several objects from the OUNL_CITO model.

The Decision making is the stage, part of the OUNL – CITO model, which was removed and is not part of the TenCompetence assessment specification. This stage is not part of the assessment process itself, but rather of the assessment follow-up (what decisions we can take regarding further competence development of the person assessed). For example, in the TenCompetence project, this stage is linked to the problem of positioning – if a learner was assessed, and having her/his assessment results, we have to position her/him inside the competence map. Or this may be linked to planning of learning activities, in order to assign the proper learning path, leading at the end to the achieving of the desired competence. Any additional modelling activities, which can be linked with this stage, we can specify through the Assessment plan, in the Assessment Design stage.

In the first stage of the OUNL – CITO model: Assessment Design stage, two objects were removed: Assessment Function and Assessment Type. They both contain only one attribute of type text, and can be replaced if needed with additional attributes in the
Assessment Plan. For example, the Assessment Function describes general objective or aim of the assessment plan like diagnose, intake, position or certificate. The Assessment Session object was also removed, as it is a particular instantiation of the Assessment Scenario object, which is linked to the Assessment run stage. Any such run-time specific objects should be moved, modeled or supported by the run-time environment. The second stage of the OUNL – CITO model: Item Construction stage, is kept the same, and contains the same information objects. In the third stage of the OUNL – CITO model: Assessment constructing stage, two objects were removed - Unit Of Assessment Trait and Unit Of Assessment Definition. The Unit Of Assessment Definition, for example, can be represented as a combination between Unit of Assessment and Unit of Assessment Trait reply for Trait. The fourth stage of the OUNL – CITO model: Assessment Run stage, is kept the same, and contains the same information objects. In the fifth stage of the OUNL – CITO model: Response Processing stage, three information objects (Assessment Indicator Score, Trait Score, Rubic Score), for simplicity, were replaced by only one object – Rubric Score.

In the following table we show the comparison between the original OUNL/CITO model and the new simplified TenCompetence assessment model in the form of a matrix. The sign “X” is used to show if the corresponding object is available in the appropriate model or no.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Original Aspects (Objects)</th>
<th>OUNL/CITO model</th>
<th>Simple Assessment Model</th>
</tr>
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<td>X</td>
</tr>
<tr>
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<td>Assessment Scenario</td>
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<td>X</td>
</tr>
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<td></td>
<td>Assessment Session</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assessment Function</td>
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<td>Assessment Policy</td>
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<td>DecisionRule</td>
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<td>Trait</td>
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<td>Hint</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
C.5.2.2 The resulting model

The TenCompetence assessment specification, as a simplification of the OUNL/CITO model, follows the same approach for the modelling of the competence assessment process. It contains the following stages: Assessment design, Item construction, Assessment construction, Assessment run and Response rating.

This model also allows to distinguish the assessment process in two main phases: design phase (including the stages Assessment design, Item construction, Assessment construction) and run-time phase (including the stages Assessment run and Response rating). These phases can be used when developing tools to support the competence assessment process. The TenCompetence assessment specification is presented as UML diagram in the next figure:
C.5.2.3 Assessment design

The main object in this stage is the Assessment Plan. It is defined in terms of units of assessment and their assessment types, as specified from the assessment scenario, determining their sequence and time dependencies. The Assessment policy prescribes which assessment types (methods) can be used and on which conditions. The Trait is an abstract object used to measure different personal characteristics. Usually this is used for competence assessment. There could be different assessment types: 360 degree feedback, peer assessment, self-assessment, essay assessment, on-the-job assessment, portfolio assessment and others.

Here we will delete the Decision Rule object from the original assessment model, as an object out of the scope of the Assessment process itself. Next follows the UML diagram of the Assessment Design phase which was described above:
Identifying the most appropriate people to rate the performance of the individual is a key part of the process. Ideally the recipient will have full involvement in identifying who they think is in the best position to comment on their performance. In context of the Assessment Model all participants in the process are called Population, and the assessed competence or performance level - Traits.

It is also important to consider briefings with all participants on the objectives of the process and some basic tips for completing the questionnaire, called Assessment Policy, for example highlighting the importance of marking observed behaviour.

**C.5.2.4 Item construction**

The main object in this stage is called Item. It is used to measure particular competence (trait) using specific indicators. There could be three Item types: construction, selection and demonstration. For the proper description of the functionality of the Item, the following components are used: Prompt, Case text, Hint and Feedback. 360-degree feedback is a questionnaire-based diagnostic method. So the Item Construction Phase is one of the most important, when well-designed questionnaires have to be developed.
Some questionnaires include a free-written section in which other observations or comments may be made. This can help to throw more light on the ratings, but again the person giving the feedback needs to be sensitive in managing this information. The *Items* could be of the *SelectionItem* form, in one of the follow types like multi-choice, multi-response question or open question related to different competencies.

### C.5.2.5 Assessment construction

The central object in this stage is called Unit of Assessment. Each Unit of Assessment corresponds to particular Type of assessment and includes one or more *Items*. It defines the type and value of the Scale which specify how the candidate’s response has to be translated into a score. There are two types of scales: numeric and nonnumeric scale.

During this phase of the assessment model, in the context of the 360 degree method, the Unit Of Assessment is formed by choosing and incorporating appropriate questions, which are called AssessmentItems in the Assessment Model, which are forming the 360 Degree questionnaire.
As a general rule, the number of questions may depend on what the feedback is used for. If the assessment is used for individual development, the survey should be brief—usually no more than 50 questions. Most organizations focus on core competencies or key areas, thereby reducing the number of areas for feedback. The second important step in this phase is to define the Scale. It could be Numeric or NonNumeric Scale. Most 360 degree assessments use four different types of rating scales: 1) Effectiveness; 2) Potential; 3) Ranking and 4) Frequency. Effectiveness scales ask participants to provide judgments about how “effective” the individual demonstrates specific competencies and underlying behaviours. Potential scales are more commonly used for succession planning systems and ask raters to predict how well the participant might perform in the future or what potential they have to succeed. Ranking scales typically ask participants to compare to some type of standard (e.g., evaluate the person assessed compared to the most effective leader that he/she has experienced within their organization). Frequency scales typically ask about how often the person assessed has demonstrated or expressed specific behaviours.
- **Numeric Scale** - a questionnaire used for 360 Degree Feedback typically contains statements that are rated on least seven rating options, and a ten-point scale provides for an even greater spread of responses.

- **NonNumeric Scale**: the ratings of the different groups are presented separately, and the range of the ratings (i.e. highest and lowest) as well as the averages included so that these differences in perspective are identified. If there are enough raters involved, this should not compromise anonymity. The feedback should also be reviewed for sensitivity in how the information on the ratings is presented and in particular how the implications of lower ratings are conveyed.

### C.5.2.6 Assessment run

The main object in this stage is called Assessment session. It includes parameters like date, time, and one specific component – assessment take, which specifies how the assessment is implemented. The output of the assessment is recorded in the object Item response. The content of the item response depends from the type of the assessment. Below we give an example for the 360 degree assessment method.

**Assessment Take** - the candidate receives an on-line or other kind form in order to fill it. Questionnaires typically include from 50 to 100 statements. When estimating the amount of time to complete the questionnaire you should estimate about 1 minute per questionnaire statement.

**ItemResponse** - Responses are collected for items that fall under a specific dimension of job performance. A single questionnaire may contain dozens of questions that measure responses on one or more dimensions. For example Communication Items measure the ability to present information formally and informally in both written and orally. Also measures the ability to communicate with customers, staff, peers and supervisors.

**Candidate – Person or Group** - Limited research is available to guide decisions on the optimum number of raters necessary to increase validity of 360 feedback results. The few studies that are published provide some guidelines suggesting that 8 to 10 raters for each rater group invited to participate to maximize accuracy of the feedback (Nowack, 2005).
**C.5.2.7 Response rating**

The main object in this stage is called Assessor. It is used to measure the particular assessment providing rubric score with the necessary assessment item indicators, and to compute the needed scores.

The Assessor could be either human or machine. First the assessor transforms the candidate’s response (Item Response) into a rubric score using the defined transformation rules. The second step is to calculate the Assessment Indicator Score for each candidate, which is the aggregated score for all Items within the Unit of Assessment that measure the same Indicator. At the end assessor compute the score on a trait, based on indicator scores (aggregating the related assessment indicator scores), which applies to only one candidate. In Response Processing Phase, evaluation is performed on the basis of statistical methods.

In the 360 degree feedback method, the feedback will usually result in three types of information:

- **Absolute assessment**: The specific grades for particular areas of performance can be calculated as mean values from the results.
- **Relative assessment**: A specific target value can be applied, or the assessments of the various comparison or reference groups can be seen together.

- **Self evaluation versus external assessment**: It is also interesting to compare the self-evaluation with the evaluation by the reference groups.

*The Assessor* in this method is used for providing the individual gap analysis reports, which identify the candidate for each behavioural indicator. These ratings are compared with both the target rating and the average rating of all others who have self-assessed against the same competence. Results are displayed graphically for each question, detailing the self-rating, the target rating and the average rating of other users. A similar graphic is shown to demonstrate the rolled-up ratings for each competency.

### C.6 Exemplified pedagogical scenarios

In order to evaluate the TenCompetence Assessment Specification, we present two examples of the use of the specification to model competence assessment within pedagogical scenarios for competence development.

#### C.6.1 Portfolio Assessment

The candidate enters the TenCompetence Network and registers his/her portfolio in the System as a starting point to apply for a role requested and being assessed later through different assessment types. The registration of portfolio could be assumed as a stage zero (0) of the assessment process (in addition to the stages defined in the Simplified Assessment Model, otherwise a portfolio assessment could not be conducted.

We assume that there is a new candidate who enters the network, registers his/her portfolio and applies for the role “teacher in English language”. We also assume that the role “teacher in English language” of the competence map includes the following set of competences:

- Competence A – teaching ability/skills
- Competence B – level of command of English language

In case of more than one competence to be assessed, as we have in the present case, specific type of assessments could be developed and applied for each separate
competence in the defined set in order to suit its nature aiming to being exhaustively and completely assessed. Depending on the particular case, one Unit of Assessment may be more appropriate than another. In our case with two competences A and B required for the role “teacher in English language”, the candidate should take two competence assessments which will be done through using the following new types of assessment:

- Competence Assessment for Competence A performed as Portfolio Assessment.
- Competence Assessment for Competence B performed as Peer Assessment and/or Test.

We first examine the assessment of competence A – Teaching ability/skills

<table>
<thead>
<tr>
<th>Stage 1: Assessment design</th>
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</thead>
<tbody>
<tr>
<td>Assessment Plan</td>
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</tbody>
</table>
| Assessment Scenario        | Each portfolio is a purposeful selection of works which means that it has its concrete goals in a concrete context connected to the specific role to be attained. In that connection, in order for thoughtful assessment to take place for the role of “teacher in English language”, the following important criteria for a finished and relevant for the role portfolio are defined in order of priority to show quality rather than quantity (the highest priority first):

1. **Completeness, correctness, and appropriateness** of works (products and processes) presented in the portfolio. Portfolio might include; course planning and preparation; actual teaching presentation; description of efforts to improve one’s teaching evaluating Learners and giving feedback; representative course syllabi; summary of institutional instructor evaluations by Learners. SEE ANNEX 1 “TEACHING MATERIALS” for possible evidence entries in the portfolio in order to show and demonstrate the criteria characteristics.

2. **Thoughtfulness** - including evidence of monitoring of own comprehension, metacognitive reflection, and productive habits of mind; statement of teaching responsibilities; statement of teaching philosophies and methodologies. SEE ALSO ANNEX 1.

3. **Diversity of entries** - use of multiple formats to demonstrate achievement, processes, skills and knowledge.

4. **Growth and development** in relationship to curriculum and key indicators.

5. **Understanding and application of key processes**.

The following options for measurements of the criteria above is proposed:

1. Criterion: **Completeness, correctness, and appropriateness**
   1.1. *not completed portfolio* (definition: no enough entries in the portfolio to carry out the assessment i.e. poor portfolio)
   1.2. *basic level portfolio* (definition: few basic entries of satisfactory level of quality correctly showing the candidates abilities, knowledge, skills concerning the role to be attained)
### Stage 1: Assessment design

1. **good portfolio** (definition: quite enough quantity of appropriate portfolio entries of good quality in order to assess it fully accurately in the sense of completeness, correctness and appropriateness in respect to each one of the traits of the competence; showing some strengths)

2. **high level portfolio** (definition: modern approaches in development of portfolio applied, many relevant comprehensive records of high quality included, exhaustively specified and described; showing strengths; it is clear and no doubt that the person is high professional in the field; has statements on each item that show their relation to the overall responsibilities and how they reflect his or her status as a teacher)

2. **Criterion: Thoughtfulness**
   - **not evident** (definition: there isn’t entries showing own responsibilities, philosophies and teaching methodologies used)
   - **partially evident** (definition: some records describing own responsibilities, philosophy and teaching methodologies used; more general statements)
   - **clearly evident** (definition: clear idea about the responsibilities and their accurate execution; own teaching philosophy and methodologies defined and applied resulting in better quality teaching and education process)

3. **Criterion: Diversity of entries**
   - **sparsely** (definition: not enough formats used demonstrating the works included into the portfolio in order to assess it accurately in the sense of diversity of entries)
   - **minimum diversity** (definition: some typical basic formats demonstrating works included into the portfolio in order to assess it but still not enough to assess it fully accurately in the sense of diversity of entries in respect to each of the traits of the competence)
   - **accurately** (definition: typical basic formats presenting works included into the portfolio in order to assess it fully accurately in the sense of diversity of entries in respect to each one of the traits of the competence but still something additional for the role could be added into the portfolio as demonstrating format)
   - **high diversity** (definition: modern approaches in development of portfolio applied and many entries in different formats, including self-reflection, table of contents and cover letter, included into the portfolio in order to assess it fully accurately in the sense of diversity of entries in respect to each one of the traits of the competence)

4. **Criterion: Growth and development**
   - **not evident** (definition: there isn’t professional growth plan; no professional goals defined and respectively achieved)
   - **partially evident** (definition: has professional growth plan, goals defined and partially achieved)
   - **clearly evident** (definition: has detailed elaborated professional growth plan; set clear goals and means for accomplishment of these goals)

5. **Criterion: Understanding and application of key processes**
   - **not evident** (definition: no evidence of understanding and application of key processes)}
Stage 1: Assessment design

| 5.2. low level (definition: evidence of understanding but no evidence of application of key processes in respect to the role) |
| 5.3. medium level (definition: evidence of understanding and application of key processes in respect to the role according to the basic standards and approaches) |
| 5.4. high level (definition: evidence of understanding and high application of key processes in respect to the role according to the standards and approaches, as well as innovation methods) |

Assessment Policy
The assessment aims to provide accurate information about the skills and knowledge in English language of the candidate in order to assign him/her or not the role “teacher in English language”. It is important to be stated that the result achieved or decision taken based on the above described assessment scenario will be combined together with the result of assessment of competence A conducted through 360 degree feedback in order to finally decide about the candidate and if s/he fully fits for the role.

Trait
Four elementary traits will be observed and examined:
1. Oral Skills (Speaking and Listening); 2. Reading Skills; 3. Writing Skills; 4. Teaching approach

Decision Rule
Not only is it important to agree on the criteria that will be used to judge portfolio, but it is also important to agree on how each of these performance criterion will be weighed relative to the others.
The case concerns assessing a candidate’s English language skills through assessment of the following four traits 1. Oral Skills; 2. Reading Skills; 3. Writing Skills and 4. Teaching approach.
The successful candidate could win the role of “teacher in English language” (if having fluency in English language – competence B assessed and positive result achieved) if the results from the assessment are reaching the following levels under the different criteria defined - at least 1.3 (could be also 1.2) plus at least 2.2 plus at least 3.3 plus at least 4.2 plus at least 5.3. Some higher measurements on concrete criterion than the mentioned above could compensate to a certain extent some lower results on other criterion still depending on each concrete case and candidate.

Stage 2: Item construction

<table>
<thead>
<tr>
<th>Trait (complex)</th>
<th>Oral Skills (Speaking and Listening)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items</td>
<td>Evidence for:</td>
</tr>
<tr>
<td></td>
<td>- establishing and keeping dialogue</td>
</tr>
<tr>
<td></td>
<td>- understanding questions</td>
</tr>
<tr>
<td></td>
<td>- asking questions</td>
</tr>
<tr>
<td></td>
<td>- vocabulary</td>
</tr>
<tr>
<td></td>
<td>- getting message across</td>
</tr>
<tr>
<td></td>
<td>- summarizing the main points</td>
</tr>
<tr>
<td></td>
<td>- grammatical accurateness</td>
</tr>
<tr>
<td></td>
<td>- state own opinion clearly</td>
</tr>
<tr>
<td>Prompt</td>
<td>none</td>
</tr>
<tr>
<td>Case text</td>
<td>none</td>
</tr>
</tbody>
</table>
### Stage 2: Item construction

<table>
<thead>
<tr>
<th>Trait (elementary)</th>
<th>Reading Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Items</strong></td>
<td>Evidence for:</td>
</tr>
<tr>
<td></td>
<td>- correct and clear pronunciation</td>
</tr>
<tr>
<td></td>
<td>- self-correcting</td>
</tr>
<tr>
<td></td>
<td>- normal reading speed</td>
</tr>
<tr>
<td></td>
<td>- correct intonation</td>
</tr>
<tr>
<td><strong>Prompt</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Case text</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Hint</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Feedback</strong></td>
<td>none</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trait (elementary)</th>
<th>Writing Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Items</strong></td>
<td>Evidence for:</td>
</tr>
<tr>
<td></td>
<td>- writing without mistakes</td>
</tr>
<tr>
<td></td>
<td>- using rich vocabulary</td>
</tr>
<tr>
<td></td>
<td>- grammatical accurateness</td>
</tr>
<tr>
<td><strong>Prompt</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Case text</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Hint</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Feedback</strong></td>
<td>none</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trait (complex)</th>
<th>Teaching approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Items</strong></td>
<td>See ANNEX 1 for the provisional detailed set of teaching materials which must be evident from the candidate’s portfolio in order the assessment to take place in way that could correctly and fully evaluate the teaching approach of the candidate and decision to be taken on that.</td>
</tr>
<tr>
<td><strong>Prompt</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Case text</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Hint</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Feedback</strong></td>
<td>none</td>
</tr>
</tbody>
</table>

### Stage 3: Assessment construction

<table>
<thead>
<tr>
<th>Unit of Assessment</th>
<th>Assessment Plan – Portfolio Assessment for candidate’s Teaching ability/skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment Items</td>
<td>Could the candidate establish and keep a dialogue?</td>
</tr>
<tr>
<td></td>
<td>Could the candidate understand questions?</td>
</tr>
<tr>
<td></td>
<td>Could the candidate ask questions?</td>
</tr>
<tr>
<td></td>
<td>Does the candidate use rich vocabulary?</td>
</tr>
<tr>
<td></td>
<td>Could the candidate get message across?</td>
</tr>
</tbody>
</table>
### Stage 3: Assessment construction

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Could the candidate summarize the main points of a conversation on a certain topic?</td>
</tr>
<tr>
<td>2.</td>
<td>Does the candidate respect the grammatical rules when speaking?</td>
</tr>
<tr>
<td>3.</td>
<td>Could the candidate state own opinion clearly?</td>
</tr>
<tr>
<td>4.</td>
<td>Could the candidate correctly and clearly pronounce the words?</td>
</tr>
<tr>
<td>5.</td>
<td>Could the candidate correct himself/herself in case of mistake done?</td>
</tr>
<tr>
<td>6.</td>
<td>Could the candidate keep normal reading speed?</td>
</tr>
<tr>
<td>7.</td>
<td>Does the candidate have correct intonation?</td>
</tr>
<tr>
<td>8.</td>
<td>Could the candidate write word, sentences and complete texts without mistakes?</td>
</tr>
<tr>
<td>9.</td>
<td>Does the candidate use rich vocabulary when writing?</td>
</tr>
<tr>
<td>10.</td>
<td>Does the candidate respect the grammatical rules when writing?</td>
</tr>
<tr>
<td>11.</td>
<td>What is the quality of the teaching materials included into portfolio in terms of correctness, appropriateness, thoughtfulness, individual growth and development, understanding and application of key processes?</td>
</tr>
</tbody>
</table>

| NonNumeric Scale | Criterion 1:  
not completed portfolio / basic level portfolio / good portfolio / high level portfolio  
Criterion 2:  
not evident / partially evident / clearly evident  
Criterion 3:  
sparsely / minimum diversity / accurately / high diversity  
Criterion 4:  
not evident / partially evident / clearly evident  
Criterion 5:  
not evident / low level / medium level / high level |

| Scale Value | Criterion 1:  
1.1. / 1.2. / 1.3. / 1.4.  
Criterion 2:  
2.1. / 2.2. / 2.3.  
Criterion 3:  
3.1. / 3.2. / 3.3. / 3.4.  
Criterion 4:  
4.1. / 4.2. / 4.3.  
Criterion 5:  
5.1. / 5.2. / 5.3. / 5.4. / |

### Stages 4 and 5: Assessment run and Response rating

**Assessment Take**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Could the candidate establish and keep a dialogue?</td>
</tr>
</tbody>
</table>
| 2. | Criterion 1:  
not completed portfolio / basic level portfolio / good portfolio / high level portfolio  
Criterion 2:  
not evident / partially evident / clearly evident  
Criterion 3:  
sparsely / minimum diversity / accurately / high diversity |
## Stages 4 and 5: Assessment run and Response rating

Could the candidate understand questions?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate ask questions?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Does the candidate use rich vocabulary?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate get message across?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate summarize the main points of a conversation on a certain topic?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Does the candidate respect the grammatical rules when speaking?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity
## Stages 4 and 5: Assessment run and Response rating

Could the candidate state own opinion clearly?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate correctly and clearly pronounce the words?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate correct himself/herself in case of mistake done?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate keep normal reading speed?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Does the candidate have correct intonation?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Could the candidate write word, sentences and complete texts without mistakes?
Criterion 1:
not completed portfolio / basic level portfolio / good portfolio / high level portfolio
Criterion 2:
not evident / partially evident / clearly evident
Criterion 3:
sparsely / minimum diversity / accurately / high diversity

Does the candidate use rich vocabulary when writing?
### Stages 4 and 5: Assessment run and Response rating

| Criterion 1: | not completed portfolio / basic level portfolio / good portfolio / high level portfolio |
| Criterion 2: | not evident / partially evident / clearly evident |
| Criterion 3: | sparsely / minimum diversity / accurately / high diversity |

Does the candidate respect the grammatical rules when writing?

| Criterion 1: | not completed portfolio / basic level portfolio / good portfolio / high level portfolio |
| Criterion 2: | not evident / partially evident / clearly evident |
| Criterion 3: | sparsely / minimum diversity / accurately / high diversity |

What is the quality of the teaching materials included into portfolio in terms of correctness, appropriateness, thoughtfulness, individual growth and development, understanding and application of key processes?

| Criterion 1: | not completed portfolio / basic level portfolio / good portfolio / high level portfolio |
| Criterion 2: | not evident / partially evident / clearly evident |
| Criterion 3: | sparsely / minimum diversity / accurately / high diversity |
| Criterion 4: | not evident / partially evident / clearly evident |
| Criterion 5: | not evident / low level / medium level / high level |

**ItemResponse**  | Stored the response for every item.
C.6.1.1 Activity Diagram
C.6.2 360 degree assessment

The candidate comes in the TenCompetence Network but he/she does not have a portfolio registered with the System. It’s important to specify if the candidate could apply for the role “teacher in informatics”. The role “teacher in informatics” of the competence map includes the following competences:

- Competence A – teaching capability
- Competence B – programming in some computer language

Specific Competence Assessments can be developed to suit the nature of the competence that is being assessed. Depending on the particular situation, one Unit of Assessment may be more appropriate than another. The candidate should take two competence assessments which include the following type of assessment:

- Competence Assessment for Competence A performs as 360 degree feedback, process in which candidate evaluates himself/herself on a set of criteria and manager evaluates him/her.
- To evaluate the Competence B it’s appropriate to use Peer Assessment in the specific domain.

<table>
<thead>
<tr>
<th>STAGE 1 – Assessment design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment Plan</td>
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<tr>
<td>Assessment Scenario</td>
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<tr>
<td>Assessment Policy</td>
</tr>
</tbody>
</table>
Please respond as you honestly see the behaviors. There are no right or wrong answers.

**Trait** | Decision Rule
---|---
| there are two elementary traits: *Listening and Dialogue*  
If we are assessing a person's teaching capability, we might assess these two traits: ability to listen and to make dialogue with Learner. If the results are complete up to 50% the user could be a teacher.

### STAGE 2 – Item construction

<table>
<thead>
<tr>
<th>Trait</th>
<th>Listening</th>
</tr>
</thead>
</table>
| **Items** | 1. Listens to others without interrupting.  
2. Listens to others without reacting emotionally.  
3. When listening, gives full attention to the speaker.  
4. When listening, asks questions to check understanding.  
5. When listening, checks the meaning of the speaker's tone of voice, gestures and facial expressions.  
6. When listening, summarizes the speaker's thoughts, feelings and ideas. |
| **Prompt** | Your objective feedback will provide insight into this individual’s strengths and opportunities for teaching capability. Please respond as you honestly see the behaviors. |
| **Case text** | none |
| **Hint** | none |
| **Feedback** | none |

<table>
<thead>
<tr>
<th>Trait</th>
<th>Dialogue</th>
</tr>
</thead>
</table>
| **Items** | 1. States own opinions clearly.  
2. Communicates without ridicule, threats or emotional outbursts.  
3. Uses consideration and tact when offering opinions.  
4. Explains the reasoning behind own opinions.  
5. Asks others for constructive evaluation of own opinions.  
6. Asks others for their opinions.  
7. Asks others about the reasoning behind their opinions. |

### STAGE 3 – Assessment construction

<table>
<thead>
<tr>
<th>Unit of Assessment</th>
<th>Assessment Plan - 360 degree assessment for person’s teaching capability</th>
</tr>
</thead>
</table>
| **Assessment Items** | 1. Listens to others without interrupting.  
2. When listening, gives full attention to the speaker.  
3. When listening, asks questions to check understanding.  
4. When listening, checks the meaning of the speaker's tone of voice, gestures and facial expressions.  
5. When listening, summarizes the speaker's thoughts, feelings and ideas.  
6. States own opinions clearly.  
7. Uses consideration and tact when offering opinions.  
8. Explains the reasoning behind own opinions.  
9. Asks others for constructive evaluation of own opinions.  
10. Asks others for their opinions. |
<table>
<thead>
<tr>
<th>NonNumeric Scale</th>
<th>Not satisfied</th>
<th>Minimally satisfied</th>
<th>Moderately satisfied</th>
<th>Very Satisfied</th>
<th>Totally satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale Value</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**STAGE Assessment run & Response rating**

1. Listens to others without interrupting.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

2. When listening, gives full attention to the speaker.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

3. When listening, asks questions to check understanding.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

4. When listening, checks the meaning of the speaker's tone of voice, gestures and facial expressions.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

5. When listening, summarizes the speaker's thoughts, feelings and ideas.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

6. States own opinions clearly.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

7. Uses consideration and tact when offering opinions.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

8. Explains the reasoning behind own opinions.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

9. Asks others for constructive evaluation of own opinions.
   Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

10. Asks others for their opinions.
    Not satisfied - Minimally satisfied - Moderately satisfied - Very Satisfied - Totally satisfied

**ItemResponse** | Stored the response for every item.
C.7 Assessment Model Conclusions and Future Work

After the description of how we addressed the three main questions stated in the Introduction part of this Chapter, we can summarize our achievements in three main categories:

1. We developed a model integrating competence development and competence assessment processes. This model includes the following four stages:
   - orientation
   - evidence collection
   - assessment by other
   - performing competence development activities

   The model is based on the similar existing models, but is specifically oriented to the needs of the TenCompetence project. The model addresses the roles of various forms of assessment in these four stages of competence development processes.

2. We developed a technical approach to model and deliver various forms of online competence assessment. This approach is based on a combined use of the IMS LD and IMS QTI, implemented through a service-oriented software framework. In this approach a competence assessment process is modeled as a set of units of assessment. Each such unit of assessment is developed as a special unit of learning, containing one or more assessment-specific components (e.g., an IMS QTI document and/or a special assessment service). As a consequence, an assessment process model developed by adopting our approach can be delivered in any standards-compatible environment.

   This approach was proved and explained by describing the implementation of two key forms of innovative assessment. In comparison to typical software development approaches, our approach has advantages in supporting interoperability, flexibility, and a seamless integration with learning activities.
3. We developed a TenCompetence assessment specification. This specification is based on OUNL/CITO assessment model. TenCompetence assessment specification is developed by simplifying OUNL/CITO assessment model. The reasons to simplify OUNL/CITO assessment model for use in TenCompetence are:

- The OUNL/CITO model is extensive and complex, aiming for completeness in its coverage of all forms of assessment. This complexity has an impact on the usability of the model and a simplification could increase the adoption of its concepts.

- The TenCompetence Domain Model provides a larger framework into which the assessment model must be dovetailed. Some duplication of concepts is apparent in the two separate models, which could be removed through harmonisation.

As a result, TenCompetence assessment specification describes a conceptual model representing main concepts and their relationships in a whole assessment process including Assessment Design, Item Construction, Assessment constructing, Assessment Run, and Response Processing. It is important to note that TenCompetence assessment specification can be used to model a competence assessment process in a human-user understandable manner.

The work in these three main areas is logically interrelated in the following way:

- The integrated competence development and competence assessment process model describes what competence assessment is, and what roles of various forms of competence assessment in competence development processes exist.

- Based on identified characteristics of competence assessment, the technical approach is developed to model a competence assessment process in a computer-interpretable manner so that the formal model is executable.

- Because this technical approach is too difficult for practitioners to design their own competence assessment directly, TenCompetence assessment specification
is developed to enable practitioners to model a competence assessment process in a human-user understandable manner.

The main directions for the future work related to Assessment in WP6 in the next phase are:

- to develop TenCompetence assessment authoring tool based on TenCompetence assessment specification

- to develop mapping functions to transform a competence assessment process model from a human-user understandable model to a machine-interpretable model.

As a consequence, practitioners can design their own competence assessment processes by using TenCompetence assessment tool, and then execute their own designed competence assessment process models by using TenCompetence infrastructure.
D. IMS LD Run-time

D.1 Introduction

In the work reported in this section, we are addressing a number of difficult issues related to use of services with IMS LD. These have their origins in the dynamics of the development of eLearning interoperability specifications in general, and, in more specifically, the history of the IMS LD specification.

Looking at the first of these aspects, eLearning interoperability initiatives have developed as more or less coordinated explorations of various way of achieving more effective applications of Information Technology in education. There has not been an overall plan governing the way in which the domain of eLearning has been divided into areas, with each covered by a specification. Rather we have a collection of specifications, each of which responds to a need identified at the time when work on it was commenced. Each specification is explicitly or implicitly informed by theories, ideas and assumptions, which may be different or conflicting for the various specifications. Moreover, specifications are developed within a particular technological context, and as this context changes so do the consequences of using any given specification.

In eLearning today there are a relatively small number of successful interoperability specifications, many of them produced or adopted by IMS. They are the product of a great deal of effort and reflection, and a substantial amount of implementation has been carried out to support their use. This is a very valuable resource for eLearning, but

- the lack of an integrating framework means that it is hard for them to work together. One of the reasons why SCORM is important is that it performs this function of bringing together a number of IMS Specifications into an application profile, and promotes the implementation of software to run them.

- the varied perspectives which inform the specifications have implications for their use. Thus SCORM provides a valuable integrated infrastructure, but it is not capable of running sophisticated learning scenarios represented in IMS LD. Nor can IMS LD systems interoperate with SCORM objects.
Regarding the second point, IMS LD was developed by taking the OUNL Educational Modelling Language and adapting it (EML). In this process a number of the services provided by EML were removed, for two reasons:

- In order to avoid duplication those parts of EML which addressed areas already covered by other IMS specifications were removed from the IMS LD specification. This was particularly the case for the generation of tests and questions (covered by IMS QTI)

- In order to make the IMS LD specification more attractive to implementers, and to ensure that the threshold for interoperability was not too high, only a small number of simple services were included (send mail, monitor, index search). As a result a number of the integrated services in EML were removed in IMS LD (for example forums).

In TenCompetence we now have to deal with the consequences of these decisions made by IMS in the development of their specifications. The decisions were no doubt reasonable at the time, as it was a priority to develop usable specifications which would be attractive to adopters. Nevertheless the issues of interoperability between specifications and the paucity of services in IMS LD are now pressing concerns which are limiting the usefulness of the IMS suite of specifications, and hence the whole vision of eLearning based on interoperability specifications. In TenCompetence we are seeking solutions to this problem, in the first instance for the system under development, but also as a general solution for the wider context of eLearning specifications. Consequently the work we report here is not simply a technical solution to a particular implementation problem, but rather the initial results of the first serious attempt to resolve the contradictions which are inherent in the currently available set of eLearning specifications.

In this section of the milestone we first we go into greater detail on the issues which surround the use of services in IMS LD. Next we describe some of the ways which these issues are being addressed by IMS and other initiatives, which propose frameworks which could enable new solutions to the problem. This provides a wider context in which our work can be situated, but none of these initiatives is likely to produce workable
solutions for TenCompetence in the short or even medium term. Consequently we move on to discuss practical steps which can be taken to implement services within the IMS LD. Our starting point in this is work done by the Valkenburg group in establishing an architecture for the implementation of IMS LD, and in particular the work of Bill Olivier, who proposed a programme of work which has informed the approach taken by TenCompetence.

A key task in this work package is to establish a new specification for communicating between IMS LD runtime systems and services. The need for this has been established in the literature (see Bill Olivier below), but no practical work had been done to show the real needs of users in practice. Consequently the Project adopted a two pronged approach. On the one hand we worked on building a functioning system which enables IMS LD runtime to fully integrate Sharable Content Objects from the SCORM 1.2 spec. The first phase of this work was completed in the final quarter of 2006, and the demonstrator is now available. The experience of carrying out this development has shown the scale of the problem, even in this quite restricted use case. Thus the implementation work is not only intended to provide valuable functionality which can be used within the TenCompetence framework, but also to provide the basis for the identification of requirements for the connection protocol which will be a key output from our work.

The documentation for the SCORM integration discusses the background behind the task and how existing tools might be reused together. It then explains some of the issues around how to achieve integration between them, and progresses through to design issues and implementation. There is also a brief technical section on how integration was finally achieved. We will then cover the way in which an IMS LD Unit of Learning can be authored so that it can contain ADL SCORM content. Finally we will progress to a section outlining how this would look to a user and explain the runtime processes involved.

**D.1.1 Will the real service please stand up?**

In the olden days, it was the word ‘object’ which caused difficulties. Nowadays it’s ‘service’. We have web services, semantic web services, SOAs, ELF services… and we also have IMS LD’s Services. The latter form the starting point for this work – ‘web
services’ are from this viewpoint infrastructural elements which could be used in the implementation of IMSLD’s services. IMSLD offers a set of services which can be included in learning process descriptions. Designers indicate which services are available at which point in the flow. The IMSLD services are:

![Figure 31: IMS LD Level A and Level B Services](image)

Selected remarks on IMSLD services below (IMS a 2003):

- **Mail**: Fixed choice: 'all-persons-in-role' or 'persons-in-role'. With the first choice, the user agent only allows messages to be sent to the role, indicating that all persons in the role get the message. With the second choice, the user agent allows a user to select one or more individuals within the specified role to send the message to.

- **Conference**: The elements participant, observer, conference-manager, moderator facilitate the setting of the user rights in the conferences. They each contain a role-ref which associates them with a role in the learning design. If more than one role is to be assigned to a conference role (e.g. several LD roles are to be participants) then several instances of the conference role are needed, one for each LD role. It depends on the implementation how a conference is set up and managed: 1. When the conference system is an integral part of the runtime system, it is expected to be set up automatically; 2. When the conference is external, the user-rights can be set manually by the conference manager. The conference manager must be able to get a list from the runtime agent about
which conferences of what type, for what users, with what rights, need to be set up. 3. Using the data in this conference element, the conferences can also be set up by a generating scripts, configuration files or a legacy interface to the rights management system of the conferencing system. In all instances the runtime system must be able to provide this information in a structured way. The item element refers to the resource where the conferencing system is to be found or identified. External conferencing systems can be of any kind accessible through the internet (resource type is webcontent). Examples: netmeeting, placeware (synchronous), first-class, lotus notes, news groups (asynchronous). An announcement object sets the rights: creator of announcement = participant. Reader of announcements = observer.

- **Index-search**: A choice of elements to specify indexing aspects, used to set up a search service. The index is made in the background (not visible to users). The visibility is determined with the search element. The functionality of the index is dependent on the search element: - When search is free-text-search, then the index is made on the resource pointed at in the index (i.e. the underlying html texts). - When search is index-with/out-with-reference, than only an index is made of the elements which share the same class, including underlying items. This has the form of a table of content.

- **Monitor**: The monitor service provides a facility for users to look at their own properties or that of others in a structured way. A monitor service uses global properties in resources of type 'imsldcontent' to view the properties of one-self or of all users in a role.

The IMS Learning Design specification also notes:

- A service relates to a concrete service facility available at runtime. During design a service has no URL assigned to it, but must be given a URL when the Learning Design is instantiated at runtime. Examples of a Service include a discussion forum, chat rooms, monitoring tools, search facilities, etcetera. In Learning Design the conditions for setting up a service at runtime are specified at an abstract level. For example, for discussion groups it specifies which
learning design roles have what type of access (participant, observer, moderator, etc.). Note: if a discussion forum is to be used within a learning design, were it given a predefined URL, then all instances of the Unit of Learning that includes the learning design, wherever and whenever instantiated, would have the same one specific discussion forum.

- … a runtime facility (or a human) can setup the necessary facility according to the requirements. In the learning design specification, the abstract declaration of a service facility is called a 'service'. The instantiation of a service is called a 'service facility'.

Additionally, aApart from the services explicitly mentioned in the specification, there is another type of service to be handled during execution of a Unit of Learning. By default, an IMSLD can specify content as either ‘webcontent’ or imsldcontent’. However, there may also be the need to integrate other types of content, based on other specifications such as IMSQTI or ADL SCORM. In such cases, the Learning Design runtime environment may not be able process the content and may need to call a third party service with can handle the content. Later in this document we outline the processes involved in developing such a service which allow the Learning Design runtime system process AD SCORM content.

How do these concepts fit into IMSLD?

- A design might have learners operating independently, but require some triggers for them to carry out activities. The mail service could be used to alert learners by having an email be delivered to e.g. Outlook (note the relationship here to level C’s notification concept)

- Learners might be split into two groups, one ‘for’ compulsory vaccination of birds and fowl, one ‘against’. The groups would be instructed to use their chat tools (eg MSN Messenger) to come up with arguments and counter arguments which are posted in a forum shared by both groups.

- The *What is Greatness* example (Tattersall C, 2004) gives an example of the user of the monitor by both staff and Learners.
D.2 Design Considerations

As background work on the design of a new communication protocol, it makes sense to first to investigate other work in this area. The next section lists work that is related in this area and gives a brief description of what they cover.

D.2.1 Related Work

1. The IMS Tools Interoperability Specification (IMS c 2006)

- The IMS Tools Interoperability (TI) approach addresses the growing demand for a reusable mechanism for integrating third-party tools with core LMS platforms. Tools can add specialist functionality to the LMS such as assessment or discipline-specific teaching aids. The approach recommended greatly simplifies this task whilst also offering a Web Services solution equally applicable to Java and .Net implementers. The reuse of a commonly understood approach across tools will eliminate the need for bilateral solutions, thus focusing investment on adding real value to the learner experience.

- Whilst working on this approach in the IMS Global Learning Consortium, the participants also implemented a demonstrator for alt-i-lab 2005. Their implementations made use of the WSDL auto-generation tool developed by the IMS General Web Services group. The use of this tool has allowed the TI approach to be specified in UML, from which the tool produces a WSDL file which can be used with a variety of Web Services development environments. The fact that there exist working systems that have been publicly demonstrated prior to the release of this document will hopefully install confidence in the approach for other adopters and implementers.

- User authentication is handled by the LMS in each case, whilst the LMS authenticates itself to the tool using a shared secret. The approach exploits a modular context profiling mechanism to pass additional information to the tool.
• The LMS can include the user's ACCLIP profile allowing the tool to self-
  configure its user interface to the learner's precise needs.

• The optional Outcome profile states the results format required - currently
  a simple score, but could be HRXML, QTI Results, etc.

• The approach has been designed to allow additional context profiles to be
  added in the future without impacting currently supported interoperability

2. IMS Shareable State Persistence (IMS b 2006)

• The Shareable State Persistence specification describes an extension to e-
  learning runtime systems (e.g., SCORM) that enables the storage of and
  shared access to state information between content objects. There is
  currently no prescribed method for a content object to store (arbitrarily
  complex) state information in the runtime system that can later be
  retrieved by itself or by another content object. This capability is crucial to
  the persistence of the sometimes complex state information that is
  generated by a variety of interactive content (e.g., simulations) and that is
  currently stored and retrieved in proprietary formats and through
  proprietary methods.

   Systems, Microsoft, SAP AG, Siebel Systems, 2005)

• Business Process Execution Language for Web Services provides a means
  to formally specify business processes and interaction protocols.

• BPEL4WS provides a language for the formal specification of business
  processes and business interaction protocols. By doing so, it extends the
  Web Services interaction model and enables it to support business
  transactions. BPEL4WS defines an interoperable integration model that
  should facilitate the expansion of automated process integration in both
  the intra-corporate and the business-to-business spaces.
4. **Learning Design Engines as Remote Control to Learning Support Environments**  

- We propose an approach that aims at a clear separation of the learning design engine, the specification of the learning flow (as LD documents) and learning environments. According to its current state, the engine controls the learning environment with events (such as "start a new phase"), defined as a vocabulary for a set of environments, that are mapped to the environments' existing functionality (such as "create new workspace"). Thus the engine remotely controls the learning tools while the tools can initiate state transitions in the engine on specific events in the tool.


- CSCL applications are complex distributed systems that pose special requirements towards achieving success in educational settings. Flexible and efficient design of collaborative activities by educators is a key precondition in order to provide CSCL tailorable systems, capable of adapting to the needs of each particular learning environment. Furthermore, some parts of those CSCL systems should be reused as often as possible in order to reduce development costs. In addition, it may be necessary to employ special hardware devices, computational resources that reside in other organizations, or even exceed the possibilities of one specific organization. Therefore, the proposal of this paper is twofold: collecting collaborative learning designs (scripting) provided by educators, based on well-known best practices (collaborative learning flow patterns) in a standard way (IMS-LD) in order to guide the tailoring of CSCL systems by selecting and integrating reusable CSCL software units; and, implementing those units in the form of grid services offered by third party providers. More specifically, this paper outlines a grid-based CSCL
system having these features and illustrates its potential scope and applicability by means of a sample collaborative learning scenario.


- Success of dynamic outsourcing and quickly forming new business relationships are, however, dependent on three critical factors. First, to meet interoperability requirements, access to services needs to be based on open and emerging standards for enabling the service-oriented architecture (SOA) model, and in particular Web and grid services. These services may span a wide range of the outsourcing spectrum, including access to business applications, such as financial services, human resources (HR), and enterprise resource planning (ERP), and infrastructural resources, such as storage, computing resources, and application-hosting platforms. Second, the decision to outsource a part of the business process or application is critically dependent on whether a business partner can be trusted to provide an on-time reliable service. To ensure this quality of service, the service client jointly with the service provider should define a service level agreement (SLA) as a part of a service contract that can be monitored by one or both parties. The same service may be offered at different service levels (in terms of responsiveness, availability, throughput) and priced accordingly. Third, to provide fine-grained outsourcing in a cost-effective and on-time manner, it is essential to support automated management of the entire life-cycle of the business relationship: creation of service offering, creation of SLAs with possible negotiation, provisioning of applications and environments, and monitoring of SLAs both for dynamic allocation of resources and for compliance. To facilitate this automated management, the SLAs and other agreements need to be specified in machine-executable forms.

- The promise of Web services and the need for widely accepted standards enabling them are widely recognized, and considerable efforts are underway to define and evolve such standards in the commercial realm. In particular, the Web Services Description Language (WSDL) [WSDL 1.1] is already well established as an essential building block in the evolving stack of Web service technologies, and is being standardized in the W3C's Web Services Description Working Group. WSDL, in essence, allows for the specification of the syntax of the input and output messages of a basic service, as well as other details needed for the invocation of the service. WSDL does not, however, support the specification of workflows composed of basic services. In this area, the Business Process Execution Language for Web Services (BPEL4WS) [BPEL 1.1], under development at OASIS, has the most prominent status. The Choreography Description Language under development by W3C's Web Services Choreography Working Group, serves to "define from a global viewpoint ... the information exchanges that occur and the jointly agreed ordering rules that need to be satisfied" in carrying out a Web service-based transaction [WS-Choreography]. With respect to registering Web services for purposes of advertising and discovery, Universal Description, Discovery and Integration (UDDI) [UDDI v3.02] has received the most attention to date. Standards are also being developed in connection with various other aspects of Web service provisioning, such as reliable messaging, security, and resource management.

- At the same time, recognition is growing of the need for richer semantic specifications of Web services, based on a compressive representational framework that spans the full range of service-related concepts. Such a framework will enable fuller, more flexible automation of service provision and use, support the construction of more powerful tools and
methodologies, and promote the use of semantically well-founded reasoning about services. Because an expressive representation framework permits the specification of many different aspects of services, it can provide a foundation for a broad range of activities, across the Web service lifecycle. For example, richer semantics can support greater automation of service selection and invocation; automated translation of message content between heterogeneous interoperating services; automated or semi-automated approaches to service composition; more comprehensive approaches to service monitoring and recovery from failure; and fuller automation of verification, simulation, configuration, supply chain management, contracting, and negotiation for services.

**D.2.2 Providing support for services within TenCompetence**

Essentially, we want TenCompetence to lead to an infrastructure where users **turn-on, tune-in, learn about**. They open their laptop and the wireless infrastructure automatically hooks them into a network in which they are immediately able to study, discuss, train, play, watch, listen, talk, share, critique.

We have not yet achieved this, but our work in the first year of the project is a significant step in this direction, and contributes to providing an infrastructure which addresses some of today’s questions:

1. Where do I plug in my chat tool?
2. Half of my learners use MSN Messenger and the other half AOL Messenger
3. What about Wikis? Shared Spaces, CSCL tools?
4. I have an online assessment service. I want to use that as an LD service
5. I want to integrate an online game into my design.
6. I have a cohort of 2000 Learners and I’d like them to work in groups of 20, each with their own forum.
7. I need to get the transcript of the chat facility back as a post into a forum
8. I need to know whether each learner has posted in the forum
In approaching these problems we base our approach on previous work on LD implementation. The key reference in this respect is Chapter 2 in the Springer Learning Design book by Bill Olivier (Koper, R; Tattersall, C. Eds., 2005). Technical Director of JISC, Bill Olivier’s work has informed the e-Framework, which is the most significant initiative for the implementation of a service oriented approach to eLearning, and in which IMS LD has a significant role. The following extract from the chapter represented the starting point of the work reported in this milestone.

The selection of services reflects the most widely implemented and used services in online learning environments at the time of approval of version 1 of the LD specification: send-mail, conference, monitor, and index search. These services must either be provided by the player, or be separate services that are linked to by the player (e.g. they might be provided by standard email and Netnews servers respectively).... When a UOL is being set up prior to a run with a particular group of participants, the participants have first to be mapped to the roles specified in the learning design. Typically this would be done through a management utility provided with the runtime system.

The learning design is then scanned for all learning services and, with a list of participants for each role, a dedicated instance of the service is set up using the list of participants in the relevant roles and the mapping of LD roles to the service roles contained in the UOL’s service definition. Setting up the service can be done in one of two ways. If the service only has a user interface for creating instances, then setting up the service with the actual participants has to be done manually. In this case, the set-up function of the management utility should produce a human-readable list of the necessary services together with a list of people mapped to the service’s roles. If, on the other hand, the service has a machine-to-machine interface, then the management utility can produce a script to automate the process of setting up the service. The ability to set up collaborative and other services automatically is of some practical importance, as without it, the load on system administrators will result in limiting the use of such services and hence conflict with the learning goals.

Once a service has been set up, the link (URL or other identifier) to this service has to be passed back to the player, along with the reference to the service in the learning design. From then on, the LD player can treat a learning service in the same way as a learning object, by simply providing, at the appropriate point, a hyperlink to it in the learner’s web browser interface.
It is worth noting that where a service such as a conference is requested, it could be met in several ways. One of the systems available where the design is deployed could be used, or this approach could be substituted for a face-to-face meeting or a conference call with a link being made to a web page providing information about time, place, phone number and other details as appropriate.

It should also be noted that services such as computer-based conferencing systems do not have a standardised configuration interface. This means that LD management utilities are likely to produce some XML files, which will then need a further specialised transformation into the configuration calls needed for the particular service to be used. It will be of benefit if all LD management utilities produced such service configuration information in the same XML format, so a small ‘adjunct’ specification outlining this may well be produced. This would at least limit one side of the many-to-many translations that are otherwise necessary so that only one transformation needs to be written for any given service which all LD management utilities can use. In the longer term, a standard interface to the service may be produced for each service so that the ideal of plug-and-play between LD systems and services can be achieved.

Learning Services are a significant area that LD opens up, but that is as yet relatively undeveloped, both in the specification and in current LD practice.

Clearly many more services could be added to the LD specification, and it is desirable that they should be, from chat, instant messaging and white-boards, through virtual classrooms and more sophisticated collaborative services, such as virtual design environments, to sophisticated simulation and multi-user game-playing systems.

The key issue that needs to be addressed is how to add services in such a way that learning designs that use them still retain a reasonable degree of portability across different LD-compliant platforms. If all the above services were included, could any system be expected to be compliant? Or should the specification stick to the lowest common denominator for services, as in LD v.1.0, only supporting them as they become commonly available in systems?

Clearly individual institutions could extend the specification to support their own services, though they would have to adapt their LD instantiation facilities in order to integrate them.

In the meantime, this is an area that is likely to see different communities create applications profiles and optional extensions (i.e. optional for LD system implementers). The application profiles should enable both content and systems to be clearly described
so that the requirements of the one and the capabilities of the other can be determined at a glance.

One hopeful avenue will be that many of these services will come to be provided by standalone services, rather than integrated into increasingly strained Learning Management Systems (LMSs) and Virtual Learning Environments (VLEs). Such loose integration would be facilitated by both configuration and service interfaces along the lines being developed by OKI (2004) and IMS. This would allow the addition of services to become independent of particular LMS/VLE providers, but presupposes the availability of at least one instance of any such service, whether open source or commercial, for each service defined, so that anyone could make use of a service specified in a learning design.

Learning services are likely to come in two varieties: those that are available as downloadable software, either open source or commercial, which are set up as part of a local environment; and those that are set up as remote web services, which again would be either freely accessible or available on a commercial basis.

To further this approach, it would be desirable to have a registry of learning services, giving their type and the service interface they used, perhaps together with an Open Service Interface Definition (OSID) type of adaptor that could be downloaded.

**D.2.3 The way forward**

As part of the reviewing process of current specifications and related work, it was decided that it would make sense to investigate how currently one would integrate a new service into a Learning Design runtime system. CopperCore (Vogten H., Martens H., Koper R., 2006) Learning Design Engine has been around for more than two years. Since its inception, the software has grown to handle more and more complexity. It currently is at version 3.0 and boasts the ability to have new services connect to it via one of its newer components, CopperCore Service Integration (C.C.S.I.) The next section explores the integration of one such service and how the process of writing a new service is currently accomplished with the existing framework.
D.3 Integration of Existing Runtime Tools

D.3.1 Relevant work for the Ten Competence Project

The paragraphs below were taken from the Ten Competence Description of Work document concerning WP6 tasks, namely task T6.2.

Adapt existing open source authoring and publishing tools, specifically Reload, ASKLDT, CopperCore, Reload SCORM player, and CopperAuthor, UPF-QTI-tools to function as a component and service into the TenCompetence System (activity 6.1.1.2). It should allow the effective and efficient implementation of the required pedagogical models, TenC DOW page 62.

During the first 18 months activities will concentrate on CopperCore, Reload (LD & SCORM), ASK_LDT, CopperAuthor and UPF QTI tools, TenC DOW page 63.

D.3.2 Introduction

Task two work concerns the selection and integration of software toolsets for inclusion into the Ten Competence Framework. This can be divided into authoring tools and runtime tools. This section concerns runtime and as such attempts to show which specific tools we adopted to use and adapt for this work during this initial period.

D.3.3 Background

Work Package Six is geared towards the general theme of Learning Activities & Units of Learning. As a starting point for the runtime work and bearing the above in mind, two existing tools were identified as being suitable for integration.

D.3.3.1 Coppercore

CopperCore, (Vogten H., Martens H., Koper R., 2006) seemed to provide the starting point for this work. The CopperCore software can be subdivided into three sections.

(a) The Learning Design Engine software allows IMS Learning Designs to be imported, read and then executed. An archive file (zip) containing an IMS Learning Design package can be inspected, disaggregated and parsed for meaning. The constituent sections are then all stored so that a runtime piece of software can access it.
(b) The actual “runtime” section of the process is handled by what is referred to as a “player”. This is the software which allows the output from the Learning Design Engine to be formatted and presented to the user. The user can experience how the Unit of Learning “played” using a web browser. The CopperCore software also includes a player which can be used to view the Unit of Learning. (although there are other players available).

(c) As part of the CopperCore environment, another piece of software designed to be used in conjunction with the Learning Design Engine, is the CopperCore Service Integration framework, (C.C.S.I.) This is a framework designed to allow new services to be added to and extend the Learning Design Framework. These services could be either resources that a Unit of learning could want access to at runtime, such as a chat service or alternatively the service could itself be based on another e-learning specification. One example of this could be IMS QTI.
D.3.3.2 Reload SCORM 1.2 Player

The second piece of software that seemed suitable for integration was the Reload SCORM Player (Sharples, P., & Beauvoir, P., 2005). As with all runtime tools developed under the Reload project, the original intention was to have an easy to use desktop application which would encourage users to learn more about the specifications. It would be easy to download and install. Everything would run on the users desktop including the server environment which would be accessed using the local loop (http://localhost). In this respect the tools can be envisaged as single user based and therefore more of a previewing system rather than full blown multi-user system, supporting version 1.2 of the SCORM specification. It comprised of three distinct parts:

(a) Tomcat server which the runtime application runs under.

(b) Desktop client application used to manage the packages and the web server.

(c) Web application which supports the actual playing of the SCORM package within a users browser.

Figure 33: The Reload SCORM Player Desktop Client application (java swing based)
The desktop client is used to manage the packages and the web server. There were a few intentions behind having an additional desktop client. One reason was to make the management of tomcat very easy – there are buttons to turn it on & off, as well as the ability to simply click “play”, which launches the runtime application in the users browser. Additionally it makes it easy to import, delete and reset packages, or even choose which <organization> within the package to play. It was felt that the ability to see what information was being recorded as part of the process of playing the package, would be a valuable thing to implement. Further to this, the client also provides a monitoring mechanism which will allow the user to see what has happened to each items data model (data model as per the SCORM 1.2 specification).

To summarise, at the beginning of the project we had a standalone single user SCORM 1.2 engine/player available, which sat on the users desktop. Additionally CopperCore was a multi-user Learning Design Engine/Player but not yet able to process any form SCORM related content. The next task was to explore how to effectively combine functionality into one tool.
D.3.4 Design Considerations

In ADL SCORM terms, there are different types of learning content. Firstly there are “assets”. These items are in essence just vanilla web content and do not need to do anything other than to be presented to the user by the LMS, just as any other web page or word document would be. Secondly there are also Sharable Content Objects or (SCOs). A SCO is an item of learning content which is able to interact with the Learning Management System in which it is being played. It must be able to find an adapter which will allow it to do certain things. It must be able to perform certain operations on a defined data model using a defined Application Programming Interface (API). The data model in essence, holds information on how the learner interacted with the system. As an example the SCO could set a value within the data model which records how much time was spent on a given page by a user. The implementation of this differs slightly depending on the version of SCORM being used. A short paper entitled “How to use IMS Learning Design and SCORM 2004 Together” (Tattersall C, Burgos D, Vogten H, Martens H, Koper R, 2006), proposes one way of incorporating ADL SCORM content with IMS Learning Design. The paper describes how SCOs could be used as items found within a Unit of Learning. These SCOs would be Learning Objects which would appear within the Environment section of a given Activity. The paper expands on this further to describe two ways in which this could be accomplished. As the paper already describes this in detail, here is a brief summary.

The first method involves the SCO being physically located within a separate SCORM aware Learning Management System (LMS). The Learning Object within the Learning Design would simply reference the web address of the SCO running on the remote LMS. The advantage of this is that the Learning Design Runtime Environment does not have to know how to handle the SCOs runtime calls to the API. The main disadvantage is that the Learning Design Environment does not have access to the data model that the SCO interacted with. In essence it works, but there is little or no interaction between the SCO and the executing Learning Design that referenced it.

The second method of using a SCO within a Unit of Learning involves the SCO being physically part of the Learning Design package. It is directly imported into the Learning
Design runtime environment. When the SCO needs to be launched within the Learning Design Player, it is passed off to an additional piece of software known as the “Dispatcher”. The dispatcher acts as an interface to the Learning Design runtime environment and in this case, the SCORM runtime environment. It is the Dispatchers job to act as the SCORM aware LMS. It should be able to provide the correct environment for the SCO to execute in. The dispatcher will have access to the data model which the SCO interacts with. Subsequently the changes in the SCOs data model could be used to update properties and conditions within the Learning Design. This represents a much better solution as there is true interaction between the SCO and the rest of the Learning Design. The generic “dispatcher” software, had already been written for the CopperCore Runtime Environment and is also known as CopperCore Service Integration framework, (C.C.S.I.).

The second of these two solutions seemed to be the best option. It allows for greater interaction between the SCO and its context within the actual Learning Design. As the dispatcher framework already existed, then the existing SCORM functionality found within the Reload SCORM Player, would need to be adapted for this particular framework. Additionally, some work had already been successfully carried out with integration between CopperCore and IMS QTI. This involved using the “dispatcher” method to enable the learning design player to access a service called APIS, which was able to handle and process the QTI content. Accordingly, it was envisaged that the SCORM 1.2 engine could be refactored so it can be accessed as a service via CCSI. This would mean that SCORM 1.2 content that may appear inside a Unit of Learning could then be processed during a run. This would be implemented in a similar fashion to how the APIS QTI player was implemented.

The following diagram was drawn to show how the new functionality would fit in with the existing components.
D.3.5 Planning and Design

We had taken the approach of trying to integrate the SCORM functionality, in a similar fashion to how APIS the IMS QTI engine had been implemented within CCSI. However, there are couple of differences in the way SCORM SCOs may be incorporated into a Learning Design, as opposed to IMS QTI content. Whereas IMS QTI content is essentially an XML file which somehow needs to be processed and rendered, a SCO is typically a single HTML page with embedded javascript. This page needs to be able to access an APIAdapter object within the page (or frameset hierarchy) as it is being taken.

Figure 35: How the SCORM 1.2 Engine fits into the existing framework
Based on the original diagram from http://sled.open.ac.uk/web/tech/cesi.jsp

Top Frame – *this contains the APIAdapter object*

<table>
<thead>
<tr>
<th>This frame would typically hold some sort of navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContentFrame</td>
</tr>
<tr>
<td>1. The SCO is loaded into the frameset, typically in this Content Frame</td>
</tr>
<tr>
<td>2. It starts to look for the API adapter object within this frame. If not found it will search any parent frames for the object.</td>
</tr>
<tr>
<td>3. If it cannot find the adapter, then an alert box will open informing the user</td>
</tr>
</tbody>
</table>

Figure 36: How the traditional SCO is loaded into a Frameset
The previous diagram illustrates the concept of the relationship between the SCO and the API adapter in a typical LMS frameset system (although this is not the only way to do this).

Note, not all SCORM LMS use framesets. Another involves the use of layers or <div> tags inside a given page. There are a number of ways of actually implementing a SCORM API adapter. Some solutions use a java applet which is embedded into one of the frames, while others may use Active X or another technology.

The adapter needs to be accessible from the SCO using javascript and is referenced as an object. In the case of SCORM 1.2 the object must be declared as “API”. Once the SCO has found this object, it can then issue commands to the data model.

D.3.5.1 The existing Reload SCORM Player software

D.3.5.1.1 The API Adapter

In the Reload SCORM Player, the API Adapter was written purely in javascript. All of the API calls and rules were implemented as a set of objects in javascript. The one drawback to this is that javascript running inside a browser, cannot write to the file system. Thus, there was no way of storing the information between sessions. To solve this problem an additional hidden frame was used within the frameset, which contained a web form. When the data model for the SCO needed to be saved the model was passed as a series of name/value pairs to the hidden frame. The form in the hidden frame was then submitted to the Java servlet backend which could commit the model to disk. The frame in which the SCO resided could not reload itself, because it would lose its current state information. This is why a hidden frame was used.

At the time of writing the Reload SCORM Player code, the technology known as “Ajax” was not widely available. An Ajax call within a web page can call the backend web server for new content without having to reload the entire page.

D.3.5.1.2 Reusing other pieces of the Reload SCORM Player framework

As previously mentioned, there are a number of parts to the software. We had already identified that we would need to re-use the javascript API adapter. Additionally we would need to re-use part of the SCORM engine web application. This specific bit of
code could handle other attributes of the data model, which we would need to model within the new C.C.S.I. version. Specifically the server side model which was written in java had additional functionality. For example it could hold the state information of a SCO once it has been initialised. It also held the whole model in such as structure that could make it very easy to query – something which would be needed.

![Diagram](image)

**Figure 37: The structure of the SCORM runtime software**

One of the first jobs was be to uncouple the constituent parts mentioned above and isolate the engine and user interface parts. The code was written in such a way that this was relatively straight forward. Additionally, we had to identify what exactly the engine as a service should be able to do – what information does it have to process and what information does it need to return in order for it to become an effective SCORM 1.2 SCO service which can be used via CCSI.

At this point we made a design decision. The aim and intention of integrating the new SCO service into CCSI was to be able to execute a SCO and for the results of this to influence Learning Design properties & conditions. If a single SCO is played, then once an appropriate property is updated within the Learning Design, the SCO data model is no longer needed by the Learning Design runtime environment. Thus, the SCO data model could be held in memory until it had been finished by the user, then it could be disposed of.
D.3.6 Implementation

D.3.6.1 Changes to the Learning Design Manifest

For a Learning Design runtime environment to be able to process a particular learning object as special SCORM content it must be able to identify it within a IMS Learning Design manifest. There are two types of resource that can normally be found within a manifest. The first is vanilla “webcontent” – meaning any content that can be shown within a browser. The second is “imsldcontent” – a special type that indicates an xml file that needs to be processed and treated differently under the runtime system.

As part of adding in QTI functionality, the authors had decided to extend this list so that a QTI item could be identified by using the type "imsqti_item_xmlv2p0". Following this convention we used “adl_sco_v1.2”. The following xml fragment shows how this appears within the resources section of the manifest.

```
<resource identifier="LO-SCO" type="adl_sco_v1p2"
href="SCORM/sco.html">
  <file href="SCORM/sco.html"/>
  <file href="api/APIWrapper.js"/>
  <file href="api/SCOFunctions.js"/>
</resource>
```

The Learning Design runtime environment now has a way to interpret that this resource is a version 1.2 SCORM SCO.

*Note:* We decided not to use “adl_SCORM_v1p2”, as this could be interpreted as a zip package containing a full SCORM 1.2 course, including its own manifest.

D.3.6.2 Mapping a Learning Design Property to a SCO data model element

One question in marrying IMS Learning Design and ADL SCORM 1.2 together is, “How does the unit of learning interact with the SCO data model? The SCO data model has a certain format of values that can be accessed by the SCO at runtime. The following xml illustrates a typical data model for a SCO, as expressed in XML format and used by the Reload 1.2 SCORM Player.

```
<?xml version="1.0" encoding="UTF-8"?>
<!--This is a version 1.2.1 SCORM 1.2 SCO CMI Datamodel-->
<cmi>
```
As can be seen, there are various elements within the SCO data model that could be advantageous to use within a Unit of Learning. For example the value “cmi.core.session_time” will be used to hold the value of how long a user spent viewing a page.

One method to combine the two, is to design a unit of learning that has IMSLD level properties that are named to correspond with values in the SCO data model. For
example, let us imagine we have a single SCO which we wish to use inside a unit of learning. The SCO is designed to set the “cmi.core.lesson_status” to “completed” once the SCO has been taken. A typical SCO to accomplish this, may look like the following within a browser.

![SCO in browser](image)

**Simple sco**

*Objectives* Please use the links in the tree opposite to find new content based on your subject area.

Click the "Okay" button to continue

![Okay button](image)

**Figure 38: The SCO as seen within a browser**

The HTML and javascript used to author this page may look like the following.

```html
<html>
<head>
<script language=javascript src="SCOFunctions.js"></script>
<title>A very simple 1.2 Sharable Content Object</title>
</head>
<body onunload="return LMSSetValue('cmi.core.lesson_status','incomplete')">
<h1>Simple sco</h1>
<p>
<b>Objectives</b> Please use the links in the tree opposite to find new content based on your subject area.
</p>
Click the "Okay" button to continue
<form>
<table>
<tr>
<td><input type="button" value="Okay" onClick = "LMSSetValue('cmi.core.lesson_status','completed');LMSFinish('');" name=ok></td>
</tr>
</table>
</form>
</body>
</html>
```

Once the user clicks the button, the “cmi.core.lesson_status” value is set to “completed” and the SCO is finished. If the SCO model can set/get this value, we also need a corresponding “cmi.core.lesson_status” value defined as an IMSLD level B
property within the unit of learning. To accomplish this we need to define this property as shown in the following XML fragment.

```xml
<locpers-property identifier="cmi.core.lesson_status">
   <title>cmi.core.lesson_status</title>
   <datatype datatype="string" />
   <initial-value>not attempted</initial-value>
   <restriction restriction-type="enumeration">not attempted</restriction>
   <restriction restriction-type="enumeration">not completed</restriction>
   <restriction restriction-type="enumeration">completed</restriction>
   <restriction restriction-type="enumeration">passed</restriction>
   <restriction restriction-type="enumeration">failed</restriction>
</locpers-property>
```

*Note:* the use of the enumerated restriction on the values allowed. This corresponds to the values allowed for “cmi.core.lesson_status” in the SCO data model.

At this point we have the value declared within the unit of learning. However, in order for the SCO to influence and change the flow and order of the unit of learning, we would also need to define some sort of condition. The following XML fragment does this.

```xml
<conditions>
   <title />
   <if>
      <is>
         <property-ref ref="cmi.core.lesson_status" />
         <property-value>completed</property-value>
      </is>
   </if>
   <then>
      <show>
         <learning-activity-ref ref="another-item-that-wasnt-visible-before" />
      </show>
   </then>
</conditions>
```

Here we can see that the condition is set to show a new learning activity if the “cmi.core.lesson_status” property is set to “completed”. We had arrived at the point where we could express using a unit of learning, the SCO itself and the properties we wished to use to influence the outcome of the course.

The final piece of the puzzle for implementation was to create the mechanism for the SCO data model properties to actually reference the same values found with the unit of
learning as Level B properties. For this we would need to update the existing Learning Design Player software and then also add some new components

**D.3.6.3 The Runtime Learning Design Player**

The player needed to handle the new SCO 1.2 content. To do this it had to provide the SCO with the correct environment in which to communicate with the API adapter. It had to be then able set/get the correct properties which would subsequently update the unit of learning. The following subsections describe the two main parts of this work.

**D.3.6.3.1 WITHIN THE BROWSER**

The CopperCore Player is based around a Java 2 Enterprise Edition Servlet. This servlet is responsible for orchestrating the content to be delivered back to the web browser. It is not in the scope of this document to describe how this happens in detail. However, it is important to describe how this process works for SCORM 1.2 SCOs. We will assume that a link to a SCO is visible within a particular environment, but the user has not yet clicked on it.

![Figure 39: CooperCore Player: Initiating a Unit of Learning](image)

The user clicks the tree item which sends a call back to the servlet, with a request for content. The servlet realises that the content is of type “adl_sco_v1p2”. It first creates a link to a new SCO 1.2 service within the CopperCore Service Interface (C.C.S.I.) – See
next section. The SCO 1.2 service allows for a new data model to be created for the given SCO. This data model is initialised with certain values, such as the Learner name for example under “cmi.core.Learner_name”.

A string containing XML values is then assembled within the servlet which contains this data model. The XML string is associated with a XSLT transformation stylesheet. The servlet returns the XML string and the location of the XSLT back to the browser. The xml string will look similar to the following code.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="xsl/sco12content.xsl"?>
<SCORM>
<SCO>
<datamodel>
<cmiitem>
  <cminame>cmi.core.Learner_id</cminame>
  <cmivalue>lduser-001</cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.Learner_name</cminame>
  <cmivalue>LDUser, A</cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.lesson_location</cminame>
  <cmivalue></cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.credit</cminame>
  <cmivalue>credit</cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.lesson_status</cminame>
  <cmivalue>not attempted</cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.entry</cminame>
  <cmivalue>ab-initio</cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.score.raw</cminame>
  <cmivalue></cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.score.max</cminame>
  <cmivalue></cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.score.min</cminame>
  <cmivalue></cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.total_time</cminame>
  <cmivalue>0000:00:00.00</cmivalue>
</cmiitem>
<cmiitem>
  <cminame>cmi.core.lesson_mode</cminame>
```
The browser then applies the XSLT stylesheet and the SCO content is loaded into the browser.
WP6 Milestone M6.1

<?xml version="1.0" encoding="ISO-8859-1"?>
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform">

<xsl:variable name="newline">
  <xsl:text>
  </xsl:text>
</xsl:variable>

<xsl:template match="/">
<html>
  <!-- Have to put this style declaration in here because Firefox won't render the Iframe properly otherwise. -->
  <style type="text/css">
    html, body{
      width:100%;
      height:100%;
      margin:0px;
      padding:0px;
      overflow:hidden;
    }
  </style>
  <xsl:element name="title">Sco Player</xsl:element>
  <xsl:element name="meta">
    <xsl:attribute name="http-equiv">Content-Type</xsl:attribute>
    <xsl:attribute name="content">text/html; charset=UTF-8</xsl:attribute>
  </xsl:element>
  <!-- include the javascript API Adapter file -->
  <xsl:element name="script" >
    <xsl:attribute name="type">text/javascript</xsl:attribute>
    <xsl:attribute name="src">js/ApiAdapter.js</xsl:attribute>
    <xsl:text disable-output-escaping="yes">-- prevent use of empty tag --
    </xsl:text>
  </xsl:element>
  <body>
    <!-- line break in output file -->
    <script>
      function loadCMIStrings_z(){
        for each select="/SCORM/sco/datamodel/smiitem">
          loadDataIntoModel("",");
        </xsl:for-each>
      }
    </script>
    <!-- line break in output file -->
  </body>
</html>
</xsl:template>
</xsl:stylesheet>
The stylesheet assembles the page in the following way:

1. Includes a reference to the javascript APIAdapter which holds the data model.
2. Creates a layer (of HTML <div> tag) which will hold the actual SCO
3. Checks that the APIAdapter has loaded
4. Sets the (source) src attribute of the layer so that it loads the SCO content
5. The SCO loads and is able to access the data model.

The user is then able to use the SCO to set/get values. Once the SCO is finished, or
the user navigates away from the page, then it must commit the updated data model back
to the server. This is where the javascript APIAdapter needed to be altered.
The main difference with the new API Adapter as opposed to the original Reload adapter, is that it now uses an Ajax call to submit the data model to the server. What follows is an excerpt of the javascript adapter with an explanation of what it does.

```
function xmlhttpPost(strURL) {  \(4\)
    var xmlHttpReq = false;
    var self = this;
    // Mozilla/Safari
    if (window.XMLHttpRequest) {
        self.xmlHttpReq = new XMLHttpRequest();
    }  \(4\)
    // IE
    else if (window.ActiveXObject) {
        self.xmlHttpReq = new ActiveXObject("Microsoft.XMLHTTP");
    }
    self.xmlHttpReq.open('POST', strURL, true);
    self.xmlHttpReq.setRequestHeader('Content-Type', 'application/x-www-form-urlencoded');
    self.xmlHttpReq.onreadystatechange = function() {
        if (self.xmlHttpReq.readyState == 4) {
            updatepage(self.xmlHttpReq.responseText);
        }
    }
    self.xmlHttpReq.send(getquerystring());  \(5\)
}

function getquerystring() {  \(6\)
    // HERE WE ASSEMBLE THE DATA MODEL INTO A QUERYSTRING
    // OF NAME/VALUE PAIRS WHICH THE AJAX CALL CAN PASS BACK TO THE SERVER
    var formData = showCurrentModelState("form");
    var pushTxt = 'pushText=' + escape(formData);
    return pushTxt;
}

function updatepage(str){
    // HERE WE CAN RELOAD NEW SERVER ELEMENTS BACK INTO THE JAVASCRIPT MODEL
}

function updateServer(){
    // ****************************
    // HERE WE NEED TO COMMIT THE DATA
    // ****************************
    var strUrl = "webplayer?requestId=6001&type=adl_sco_v1p2";
    xmlhttpPost(strUrl);
}

function LMSCommitMethod(parameter){  \(1\)
    // check that this has been called with an empty string...
    if (parameter==""){
        this.ServerSco.lastError = "201"
        return "false";
    }
    if (this.ServerSco.isInitialized == "true"){
        setTimeout("updateServer()", 500);  \(2\)
        this.ServerSco.lastError = "0";
        return "true";
    }
}
else{
    // not initialized
    this.ServerSco.lastError = "301";
    return "false";
}

(1) The SCO calls LMSCommit(). This means the data model must commit the data back to the server backend.

(2) LMSCommit() now calls the method updateServer();

(3) updateServer() sets up the URL to which the request is being made and calls xmlhttpPost().

(4) xmlhttpPost() - This is the Ajax method. This is responsible for actually submitting the data model back to the server.

(5) xmlhttpPost() calls the method getquerystring(). This assembles the data model as name value pairs and then returns the string to.

(6) xmlhttpPost() which then fires the call back to the server. (the player servlet)

Once the servlet gets this querystring from the ajax call, it then has to submit the data to the piece of software which is able to translate SCO data model elements, into IMSLD level B properties. This piece of software is the new SCO 1.2 Service and is now part of the C.C.S.I. framework of adapters.

**D.3.6.3.3 The new SCO 1.2 Service**

The SCO 1.2 service has a couple of jobs to do, but its main job is to translate the SCO data model calls into IMSLD properties. As a call is made from the browser. The actual SCO 1.2 Service is built as an adapter. This means it is a service built on the C.C.S.I. framework. It also means it has the ability to talk to some of other services that are connected to C.C.S.I.
Figure 40: The pieces of the puzzle concerned with SCO communication

In the case of the SCO 1.2 adapter, it needs to talk to the LD Engine adapter. What follows is a brief explanation of how this is accomplished.

1. The browser submits the javascript data model to the LD Player servlet.
2. The servlet passes the data model onto the SCO 1.2 service. This is possible because C.C.S.I has now been configured to know that there is a SCO 1.2 service available.
3. The SCO 1.2 service parses the name/value pairs it received indirectly from the browser, and formats them in its own data model. It will also update certain elements of the model, such as “cmi.core.total_time”. (this means the total time spent on the page)
4. For each SCO data model element it finds, it calls a method which posts events to C.C.S.I
5. The LD Engine service is listening to these event changes in C.C.S.I.
6. For some of the SCO data model elements, the event change will not be recognised. This is because not all of the SCO 1.2 data model elements have been mapped as corresponding IMSLevel B properties. However, for the ones it does recognise, it will receive the change and then propagate that change into the Unit of Learning. Thus, the unit of learning will update and now reflect the changes made at runtime. These changes were instigated by the SCO within the browser.
D.3.7 Testing the prototype with a real example

D.3.7.1 Background

The intention behind this unit of learning was to show a real example of the SCO integration with CopperCore. The idea was to author a unit of learning which would contain a SCO which would contain some sort of test. The test would manipulate the SCO data model and set a variety of values for each question, using the “cmi.interactions” section of the SCO data model. The example SCO would be based on the ADL “Maritime Navigation” example. (ADL SCORM 1.2 b, 2001) The SCO test found within the “single course example” would be extracted and changed so that it would be relevant in its new environment. The user would be able to take the SCO test and then based on answers to the test, hide or reveal further learning activities.

D.3.7.2 What the example does

This is an example which makes use of a Sharable Content Object (SCO) within a Unit of Learning to influence the structure of the course. Six acts are contained with the Unit of Learning. As the user progresses through the course, each acts structure can be updated via properties and conditions. These properties are manipulated via the SCO which has its data model element mapped against the IMSLD properties.

The SCO contains a test with five questions. The Unit of Learning itself contains 6 acts. At the start of the Unit of Learning the user is only able to access the first Learning Activity. From here the user has access to the SCO which is located within the Environment section of the Learning Activity. The user clicks on the link which loads the SCO. The user then tries to answer the questions. Once finished, the user can submit the answers by clicking the button “Post answers”. Depending on which questions the user answered correctly, the structure of the Unit of Learning will then change (although a browser refresh may be needed to reflect this). New learning activities should then appear in the following acts. These are designed to give the answers to the questions that the user answered incorrectly and also offer advice.
The user can retake the test again, until eventually he/she will get all of the questions correct. Once the user has done this, the final learning activity located in the final act can be accessed.

**D.3.7.3 Authoring the example**

To author this example, the Reload Learning Design Editor (Beauvoir, P. & Sharples, P. 2005) was primarily used. The first few stages are routine for any Learning Design and do not require detailed explanation.

Stage one was to assemble the content and import into the editor. Stage two was to create all of the learning activities, learning objects and environments. Stage three was to assemble the method. This consisted of one play and six acts – each containing a learning activity.

![Figure 41: The method of the UOL showing the acts](image)

The next stage was to define the level B properties which would correspond to the SCO data model elements we wished to monitor.
Here we can see that we defined six properties.

```
cmi.interactions.0.result
cmi.interactions.1.result
cmi.interactions.2.result
cmi.interactions.3.result
cmi.interactions.4.result
cmi.core.score.raw
```

These are the names of the SCO data model elements that we know the SCO test will manipulate at runtime. We also needed to define some conditions which would change the unit of learning as the properties were updated.
In the conditions editor, we define six conditions. The first five conditions essentially are the same and follow this format.

```
If “cmi,interactions.*.result” equals wrong
then show the remedial learning activity for that question
otherwise the question was answered correctly, so hide the remedial learning activity
```

The last condition is slightly different. In this condition, the behaviour was to show a final learning activity once all of the other questions had been answered correctly.

```
If “cmi,core.score.raw” equals 5 (all the questions are correct)
then show the completed/further reading learning activity
otherwise hide the completed/further reading learning activity
```

Once the conditions had been entered, another task was to set the type of content for the SCO test. As discussed earlier, we needed to set this to “adl_sco_v1p2”. This does not appear in the drop down list of types for a resource within the editor, but it does allow you to type it in as free text instead.

![Figure 44: Changing the resource type to adl_sco_v1p2](image)

The package could then be exported. There was one other additional task to finish the authoring process. The zip package was unzipped and the manifest edited by hand. Why? This was because although we had defined our properties in the editor, it had actually (and correctly) set the property title in the XML to the one we entered. However, at runtime, the property identifier also needs to reflect the SCO data model name. The excerpt below shows in bold what needed to be hand edited for each property. (and any other references to it in the manifest)
Once finished, the example package was re-zipped and then imported into the runtime environment, CopperCore.

D.3.7.4 Illustrating the example

The course begins. The only item that the user can take is located within the first act. The user clicks the first learning activity here. This tells the user to take a test that is located inside the environment for this learning activity.
The user clicks on the test. The test is actually a version 1.2 Sharable Content Object. The SCO contains 5 questions. The user can now take the test.

Figure 47: The Learner completes the SCO test and posts results
The user answers the questions then clicks “Post Answers”.

Figure 48: The Learner has answered some question incorrectly

Here we can see that the user got three of the questions incorrect. The questions on “Jazz”, “String Bending” and “Finger Picking” were answered incorrectly. The new Learning Activities that have appeared give the answers and some advice. The user retakes the test in the first act. This time he/she answers the “string bending” question correctly.
The new course structure only contains two items which were answered incorrectly. The user takes the test. This time we assume the user answers all of the questions correctly.
The learning activity located in the final act is now accessible. This informs the user that he/she has answered all of the questions correct and in effect he/she has finished the course.

**D.3.8 Summary of Integration work**

During the process of designing, implementation and testing of the functionality, we have seen some of the problems we currently face with connecting a new service to an IMSLD runtime system. Complexity is one of the main problems. In the CopperCore Service Interface layer, we have the ability to add in our new service. The problem arises in that actually implementing a new service, requires a knowledge of this specific application programming interface and not a defined and agreed standard. Additionally the framework is quite open, allowing the developer to write his/her own calls between LD Engine and new service. While this allows a large amount of freedom to the developer, it is also very abstract.

**D.3.9 Future possibilities of SCORM Integration**

**D.3.9.1 SCORM 2004**

SCORM has moved onto version 2004. A future possibility could be that the SCORM service could be extended to support both SCORM 1.2 and SCORM 2004 the main tasks in this work would be updating the API, as it changed between versions. There could be an extended framework within the engine where the service could determine and handle both types of content.

**D.3.9.2 Using the full SCORM package**

Additionally further work could involve the use of full ADL SCORM 1.2 (or 2004) packages as learning objects found within an IMS Learning Design package. Processing a full package of SCORM content would seem to be the next logical step in integration.
D.4 Use Cases

Aside the TenC IMS LD Authoring Tool and the TenC Assessment Tool prototypes, the WP6 tool set include also the TenC Run-time engine prototype. The latter implements the TenC Connection Protocol. This will describe how IMS Learning Design Run-time Engines can be connected to external collaboration and communication services, in order to support pedagogical models that require the use of such services (e.g. collaborative learning). The following use cases aim at describing Learner’s activities performed while using the Collaborative support service facilities and her/his interaction with the system.
# Altering activities or sequence of activities at runtime

<table>
<thead>
<tr>
<th>Description</th>
<th>This use case describes how to alter a running e-learning process that is required to be changed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary Actors</td>
<td>Learner</td>
</tr>
</tbody>
</table>
| Basic Flow | 1. The User suspends the system run by invoking the ‘Pause’ facility  
2. The User invokes the Editing Mode for performing the due changes.  
3. The User selects what to alter (i.e. activities or sequence of activities).  
4. The User performs and saves the due changes.  
5. The User resumes the run from the interruption point. |
| Alternative Flow | • *Alternative Flow of Events*:  
On the Step 1 the System suspends automatically the run since a critic situation is detected.  
On the Step 2 the System offers the User the possibility to alter the faulting process by proposing to start the Editing Mode  
• *Alternative Flow of Events*:  
On the Step 5 the User resumes the run from starting point since it is not possible to do it from the interruption point.  
• *Alternative Flow of Events*:  
On the Step 5 after the changes are saved, the System resumes the run from the interruption point.  
• *Alternative Flow of Events*:  
On the Step 5 after the changes are saved, the System resumes the run from starting point since it is not possible to do it from the interruption point.  
• *Alternative Flow of Events*:  
On every Step the User could require Help information. |
| Pre-Conditions | 1. The User has rights for altering activities or sequence of activities at runtime  
2. A critic situation happens at run time and a specific UOL requires urgent changes (e.g. modifying / supplying a missing a definition; modifying / adding resources, activities, conditions) |
| Post-Conditions | 1. The activities or sequence of activities at runtime are altered.  
2. The e-learning running process has been resumed or re-started from scratch. |
| Specific Requirements | 1. On the Step 1 the ability to suspend the process of activities and/or sequence of activities at runtime has to be provided in a simple way for the User, e.g. the ‘Pause’ facility should be invoked by a keystroke (i.e. ‘Pause’ to be associated to a specific key). |
2. On the Step 2, the opening of the Editing Mode requires the launch of an editor / authoring tool as described in the WGA part.
3. On the Step 5 the ability to resume the process of activities and/or sequence of activities at runtime from the interruption point has to be provided in a simple way for the User, e.g. by the same procedure required for invoking the suspension (i.e. by stroking the same key associated to the ‘Pause’ facility).

**Retrieve interactions and data from external Services**

<table>
<thead>
<tr>
<th>Description</th>
<th>This use case describes how interactions and data from external Services are retrieved from the Collaborative support service.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exemplary Actors</strong></td>
<td>Learner</td>
</tr>
</tbody>
</table>
| **Basic Flow** | 1. During the development of an activity the User accesses a page which has reference to a property.  
2. The player (i.e. the System) gets the data from the URL defined in the property.  
3. The data will be shown (i.e. made human-readable) in the user client in the way embedded on the page.  
4. The User carries on the activity. |
| **Alternative Flow** | • *Alternative Flow of Events:*  
On the Step 1 the User initiates a service which refers to a property  
On the Step 3 the data will be handled by the service.  
• *Alternative Flow of Events:*  
On the Step 1 During the development of an activity a condition expression is met, in which a property is referred to, and evaluated.  
On the Step 3 the player (i.e. the System) will act differently according to the evaluation result. |
| **Pre-Conditions** | Data concerning the learners interaction with the service that has to be used in the further progression of the learning process are not available. |
| **Post-Conditions** | The needed data and interactions have been retrieved and used. |
| **Specific Requirements** | None |
| **Include** | None |

**Setup collaborative service**
<table>
<thead>
<tr>
<th>Description</th>
<th>This use-case describes the process of setting up collaborative services at runtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary Actors</td>
<td>Learner</td>
</tr>
</tbody>
</table>
| Basic Flow | 1. The User accesses the collaborative tools available in the System user interface.  
2. The User selects and launches the appropriate collaborative tool  
3. The System sets up the related collaborative service. |
| Alternative Flow | None |
| Pre-Conditions | 1. During the development of an activity the User needs to cooperate / collaborate with other Learners in order to accomplish her/his tasks, therefore,  
   - Use of collaboration tools (e.g. forum, chat, MSN Messenger, Yahoo Messenger, Google Gtalk, Skype chat, AOL IM, IRC, ICQ) are needed (i.e. the UOL design devises their use), and  
   - Setup of a collaborative service is needed  
2. Collaborative tools are available. |
| Post-Conditions | A collaborative service is set up. |
| Specific Requirements | A list of collaboration tools has to be available and accessible in the System user interface. |
| Include | None |
| Open Issues | Just in case the precondition on availability of the needed collaborative tool and / or service is skipped (e.g. in the first case the collaborative tool is not listed, while in the second case the tool is listed but cannot be accessed since the related service cannot be invoked and set up), the “Altering activities or sequence of activities at runtime” use case should be considered in the ‘Error/Exception Flow of Events’ section. |

**Setup Forum**

<table>
<thead>
<tr>
<th>Description</th>
<th>This use-case describes the process of setting up a forum at runtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary Actors</td>
<td>Learner</td>
</tr>
</tbody>
</table>
| Basic Flow | 1. The User accesses the collaborative tools available in the System user interface.  
2. The User selects and launches the forum tool  
3. The System sets up the collaborative service related to a forum. |
### Alternative Flow

<table>
<thead>
<tr>
<th>Pre-Conditions</th>
<th>Post-Conditions</th>
<th>Specific Requirements</th>
<th>Include</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

### Pre-Conditions

1. The use of a forum is needed (i.e. the UOL design devises its use), and
2. A forum is available.

### Post-Conditions

A collaborative service for a forum is set up.

### Specific Requirements

None

### Include

None

---

### Setup Chat

<table>
<thead>
<tr>
<th>Description</th>
<th>Exemplary Actors</th>
<th>Basic Flow</th>
</tr>
</thead>
</table>
| This use-case describes the process of setting up a chat at runtime | Learner | 1. The User accesses the collaborative tools available in the System user interface.  
2. The User selects and launches the chat tool  
3. The System sets up the collaborative service related to a chat. |

### Alternative Flow

None

### Pre-Conditions

1. The use of a chat is needed (i.e. the UOL design devises its use), and  
2. A chat is available.

### Post-Conditions

A collaborative service for a chat is set up.

### Specific Requirements

None

### Include

None

---

### Setup Messaging Clients

<table>
<thead>
<tr>
<th>Description</th>
<th>Exemplary Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>This use-case describes the process of setting up a Messaging Client at runtime</td>
<td>Learner</td>
</tr>
</tbody>
</table>
| **Basic Flow**   | 1. The User accesses the collaborative tools available in the System user interface.  
2. The User selects and launches the Messaging Client.  
3. The System sets up the collaborative service related to a Messaging Client. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Flow</strong></td>
<td>None</td>
</tr>
</tbody>
</table>
| **Pre-Conditions** | 1. The use of a Messaging Client is needed (i.e. the UOL design devises its use), and  
2. A Messaging Client is available.                                                                                                           |
| **Post-Conditions** | A collaborative service for a messaging client is set up.                                                                                     |
| **Specific Requirements** | None                                                                                                                                 |
| **Include** | None                                                                                                                                 |

### Collaborate at runtime

<table>
<thead>
<tr>
<th><strong>Description</strong></th>
<th>This use case describes the process of using the collaborative tools at runtime once their related services have been setup.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exemplary Actors</strong></td>
<td>Learner</td>
</tr>
</tbody>
</table>
| **Basic Flow** | 1. The collaboration tool launched in Step 2 of the “Setup collaborative service” use case opens.  
2. The User uses the collaboration tool according to her/his needs.                                                                 |
| **Alternative Flow** | None                                                                                                                                 |
| **Pre-Conditions** | The collaborative services related to the collaboration tools the User wants to use have been set up (i.e. the tool is available and ready to be used). |
| **Post-Conditions** | The collaboration tool launched by the User is used.                                                              |
| **Specific Requirements** | None                                                                                                                                 |
| **Include** | None                                                                                                                                 |

### Use Forum

<table>
<thead>
<tr>
<th><strong>Description</strong></th>
<th>This use case describes the process of using a Forum at runtime once its related services has been setup.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exemplary Actors</strong></td>
<td>Learner</td>
</tr>
</tbody>
</table>

TenCompetence – IST-2005-027087 - 217 -
<table>
<thead>
<tr>
<th>Use Chat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td><strong>Exemplary Actors</strong></td>
</tr>
</tbody>
</table>
| **Basic Flow** | 1. The Chat launched in Step 2 of the “Setup Chat” use case opens.  
2. The User uses the Chat according to her/his needs. |
| **Alternative Flow** | None |
| **Pre-Conditions** | The collaborative service related to the Chat the User wants to use have been set up (i.e. the Chat is available and ready to be used). |
| **Post-Conditions** | The Chat launched by the User is used. |
| **Specific Requirements** | None |
| **Include** | None |

<table>
<thead>
<tr>
<th>Use Messaging Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td><strong>Exemplary Actors</strong></td>
</tr>
</tbody>
</table>
| **Basic Flow** | 1. The Messaging Client launched in Step 2 of the “Setup Messaging Clients” use case opens.  
2. The User uses the Messaging Client according to her/his needs. |
| **Alternative Flow** | None |

---

Basic Flow

1. The forum launched in Step 2 of the “Setup Forum” use case opens.  
2. The User uses the forum according to her/his needs.

Alternative Flow

None

Pre-Conditions

The collaborative service related to the forum the User wants to use have been set up (i.e. the forum is available and ready to be used).

Post-Conditions

The forum launched by the User is used.

Specific Requirements

None

Include

None

---

Use Chat
Pre-Conditions | The collaborative service related to the Messaging Client the User wants to use have been set up (i.e. the Messaging Client is available and ready to be used).
---|---
Post-Conditions | The Messaging Client launched by the User is used.
Specific Requirements | None
Include | None

D.5 Requirements

D.5.1 Technical Requirements

This section sets out the key technical requirements for the connection protocol. The following terms are used throughout:

*Collaboration Service (CS)*

The system responsible for the provision of a collaboration interface hosted separately from the system responsible for the management of overall user activity. Examples of collaboration services include a whiteboard, shared document authoring, and instant messaging applications.

*Activity Management Service (AMS)*

The system responsible for the coordination of user activity and collaboration services. An example of an Activity Management Service is the CopperCore Service Integration component.

*Authoring Application*

The system that enables the authoring of processes that can be enacted by the Activity Management Service.
**Service Registry**

The system responsible for maintaining a directory of Collaboration Services usable by both the Activity Management Service and Authoring Application.

**D.5.2 Functional Requirements**

**Registration**

The Collaboration Service must be able to register itself with a Service Registry so that it can be discovered and incorporated into a process managed by the Activity Management Service and/or the Authoring Application.

To this end, each Collaboration Service needs to provide:

- Basic descriptive metadata, such as a title and description
- Version information
- A means of identifying service endpoints and protocols needed for service invocation.

For the last of these requirements, two approaches are possible: either the service exposes all endpoints and protocols using something like the Web Service Description Language (WSDL), or provides a URL to enable dynamic auto-discovery. The opposite operation, de-registration, should also be supported by the Service Registry.

**Authoring support**

The Collaboration Service must expose certain capabilities to support the authoring process. Specifically, the Collaboration Service must expose the parameters that can be set to configure the service. These can be simple descriptive elements (such as guidance text to show the user, framing questions etc.), presentation options (such as styles), or parameters that control the service logic (such as various processing options).

The Collaboration Service also needs to expose permission sets so that these can be mapped using the Authoring Application to roles defined within the learning design., and users allocated appropriate permissions when the Collaboration Service is launched.

**Launch**
The Collaboration Service must be capable of instantiating services for users as instructed by the Activity Management System. The Collaboration Service must provide an interface that supports the following:

- Provisioning of services with users, permissions, and activity context
- Configuration of the service

Configuration information is also described under Authoring Support. Provisioning information needs to indicate:

- The group context within which the service is provisioned (i.e. the common context of the users)
- The individual user information and permissions to be granted by the service instance to each of those users

For example, an AMS may launch a Chat CS with a group chat room context, within which most users are granted the Chat permission through membership of the Learner role, and one user is granted the Moderate permission through membership of the Teacher role. The AMS needs to communicate this context to the CS and provision it accordingly. Upon launch, the CS needs to inform the AMS how to access the individual views of the CS instance (e.g. the shared chat room, whiteboard that provides context for user sessions) for each user, and to be able to correlate subsequent service calls to the specific CS instance.

**Monitoring**

The CS needs to be able to expose the state of an instance, either in terms of individual activity (sessions) or group activity (context) to enable the tracking and monitoring of the service by the process owner. At its simplest this could be managed entirely by the CS, with provision to the AMS of a URL to reach the monitoring user interface.

**Intervention**

The CS needs to support the dynamic intervention by the process owner into a running service instance; for example, for a teacher to alter the difficulty level of an assessment either for an individual, or for all sessions in a context. The CS should expose an
interface for an instance that enables the AMS to set configuration properties dynamically during runtime in addition to at launch.

*Event Propagation*

It may be necessary for the CS to notify the AMS of events affecting the overall flow of activity external to the CS instance; in LD terms it may need to set a global property. To support this, the AMS needs to provide an interface that can be accessed by the CS at runtime.

*Termination*

The CS needs to provide a mechanism whereby the AMS can terminate an instance of a service, either for an individual session or for a complete context and all its contained sessions. On termination, the CS must provide outcome information to the AMS, such as completion state and other variables relevant to the overall Learning Design. Depending on its configuration, a CS may continue to allow access to a CS instance after termination, however this access may be determined to be read-only (a “locked” service). This may be determined using either the Launch or Intervention interfaces.

*Completion*

The AMS needs to provide a mechanism whereby the CS can indicate completion of activity within a CS instance. The AMS must provide an interface where the CS can tell the AMS the session that completed, any outcome information, and for the AMS to trigger some kind of placeholder view to be presented to that user. As with Termination, completion may occur either at the level of an individual session, or all sessions within a context.

Depending on its configuration, a CS may continue to allow access to a CS instance after completion, however this access may be determined to be read-only (a “locked” service). This may be determined using either the Launch or Intervention interfaces.

*Export*
At some point after completion of termination, the AMS may require the complete state of the CS instance to be made available as a record of activity either for user portfolios or for archiving. This may be in a static form (e.g. a PNG of a whiteboard, a text transcript of a chat). The CS should provide an export interface to support this.

**D.5.3 Non-functional Requirements**

*Browser client environment*

The solution must be capable of operating where the AMS supports a browser-based user interface (e.g. CCSI and SleD).

*Rich client environment*

The solution must be capable of operating where the AMS supports a rich client (e.g. Eclipse desktop client)

*Session management*

The CS and AMS must be capable of managing and correlating persistent sessions.

*Single sign-on*

Users should not need to sign-on independently to the CS.

*Versioning*

Collaboration Services need to support version control, and expose version information to the Service Registry and AMS.

*Standards-based*

Wherever possible and practical, the protocols used by CS and AMS should conform to existing standards and specifications.

*Privacy*

Where services are provisioned across organisational boundaries, privacy concerns of users are respected.

*Multi-organisation*
The AMS and CS should not need to be located within the same organization (learning network provider). A user should be able to create and share an activity using a CS hosted by an external provider.

### D.6 Approaches to the Solution

Bill Olivier’s input to the WP6 White Paper provides some pointers (Koper, R; Tattersall, C (Eds.) 2005):

A new ‘open service’ element is proposed in which the service type and role elements are also open. This would enable any service type, and its specific sets of roles/permissions, to be supported. While this would provide great flexibility and allow for the evolution and use of new services, the downside of this would be to weaken interoperability:

- On set up, systems may not recognise the service and hence would not be able to automatically select and instantiate it appropriately.
- When a large number of services have been created, no individual site would be able to support them all, and hence Units of Learning using unsupported services could not be supported.

**Partial solutions:**

- Provide an LD Service Vocabulary Registry. This would consist of a set of service definitions reduced to the variable parts of the Open Service Schema:

  ```xml
  <title>
  <role 1>
  <role 2>
  ...
  <role n>
  <description> // probably needed to help potential users interpret the function and appropriate use of the service
  <source-url> // a location from which the service software can be downloaded
  <online-url> // one or more locations where an instance of the service (either commercial or free) is available for use by others
  ```
<uddi-url> // the location of a WS service registry where the WSDL interface and locations of one or more instances of the service (either commercial or free) is available for use by others.

It may be necessary to distinguish and support both a set-up WS interface as well as a runtime interface type: Web interface, WSRP, WS-interface, etc.

The LD Service Vocabulary Registry would need to be at a well known location (e.g. OUNL or IMS). Everyone creating a service definition would be encouraged, first to search existing definitions and if one cannot be found, create a new one and post it to the Registry.

- Providing that services can either be downloaded and run locally, or located and used over the Internet, this problem should be reduced.

But more is needed, since information will need to be exchanged between LD engines and services; the CCSI work seems very relevant in this respect. Work we tried to bring into QTIv2 on a kind of “harmonisation spec” is also relevant here:

- In terms of relating LD props to QTI variables, we might imagine something like

```xml
<imsldqtiharm:equivalent>
  <imsldqtiharm:property-ref idref="LD-Property-X"/>
  <imsldqtiharm:var-ref idref="QTI-Variable-Y"/>
</imsldqtiharm:equivalent>
```

- This avoids the need to move to the use of XML IDs for QTI variables (although that might be a good move anyway)

- We can also imagine that we might here specify which element of a multi-valued QTI variable is desired, and also whether data type coercion is required:

```xml
<imsldqtiharm:equivalent>
  <imsldqtiharm:property-ref idref="LD-Property-X"/>
  <imsldqtiharm:var-ref idref="QTI-Variable-Y" component="1"/>
  <imsldqtiharm:coerce-to "string"/>
</imsldqtiharm:equivalent>
```

- So if QTI-ITEM-1 is an assessment level collection of items, with an associated variable “SCORE” we can imagine the following questionnaire:
So the spec we come up with will allow services which publish their presence to be found, configured, instantiated multiple times, linked to users in various roles (both roles define in a learning design and role in the conceptual world of the tool), started automatically, shut down automatically, given input at start-up or during operation, be requested to return output, either during operation or at shut down.

D.7 Proposed Solution

A solution is currently being researched, based on existing work done by IMS (the Tools Interoperability Guidelines), LAMS (Tool Contract API) and other organisations such as the Workflow Management Coalition. It is of note that project partners are also engaging with IMS in the development of IMS Tools Interoperability version 2.0, which may be a candidate specification for the connection protocol.

D.8 Exemplified pedagogical scenarios

D.8.1 Scenario One: Astronomy

The approach adopted makes uses of the role of teacher, and a role for each of the teams, Team A and Team B. The teacher is assumed to assign the Learners to one or other of the teams (to one or other of the roles).

The case study is divided into two Acts. The first act covers the team-based activity of cooperating to understand more about the naming and ordering of the planets, with the teacher offering assistance. This Act is completed when the teacher sees fit. The second Act has an individual activity for the Learners to make the associations, with the teacher monitoring the activity, declaring a winner and completing the unit of learning.
A learning activity entitled “Cooperate to name and order the planets” is defined, together with a learning activity entitled ‘Complete the questionnaire’. Two support activities are defined, “Monitor the Learner collaboration” and “Supervise completion of the questionnaire”. Extensive use is made of Environments containing Learning Objects and Services. The expert interviews are seen as Learning Objects. The forum is an IMSLD Conference of type ‘asynchronous’ and the chat rooms a Conference of type ‘synchronous’. Both the role of Team A and Team B are participants in the forum, as is the Teacher role. In this way all participants in this learning process can make use of the forum. One chat room is associated with each of the teams so that only intra-team communication is possible. In the worked out scenario, the teacher has not been granted participant or observer rights so that the chat is essentially private to a team (this could be modified so that the teacher is afforded a window on the interaction).

Two Activity Structures are defined to reflect the different situations of Team A and Team B. Each contains a reference to the learning activity of “Cooperate to name and order the planets”, and to the environment containing the shared forum service. In addition the Activity Structure for Team A has a link to an environment containing Team A’s Expert Interview and Team A’s chat room. Similarly, the Activity Structure for Team B has a link to an environment containing Team B’s Expert Interview and Team B’s chat room. In this way the cooperation and competition is facilitated. In addition to participating in the forum, the teacher is given the opportunity to set a property indicating that the first Act should end. Once set, the flow of the process moves onto the second act where each user provides an answer (via an IMSLD locpers-property) to the ordering and naming question. The teacher is provided with a view on these answers (via the monitor service) together with a mechanism to end the process and declare the winner (via a feedback-description shown on completion of the second act and containing the value of a property through global elements in so-called imsldcontent).

The setting of properties by the teacher is supported in the current version of CopperCore, with the user interface control being generated from the type of the property (eg Boolean leads to combobox). The monitor service, through which the teacher is able to follow the Learners’ attempts at the questionnaire, is implemented within the player
which accompanies the CopperCore engine. Further service integration into CopperCore-based environments has been the topic of recent R&D [4] and a loose level of integration has been achieved with Moodle. Through this integration, Moodle’s forum services are used to facilitate the inter-team cooperation, including the teacher participation.

At the time of writing, no chat service has been integrated with the CopperCore Service Integration layer, although the TenCompetence project (www.TenCompetence.org) will seek to carry out integration of Jabber during the project.

Opportunities for observation or monitoring have been incorporated into the design. First, since the teacher is also a participant in the forum, s/he is able to observe events. Had the choice been taken to offer the teacher insight into the chat rooms, this could have been modelled either by making the teacher a participant, or an observer. Further observational facilities are provided by the use of IMSLD’s monitor service when linked to specific properties (eg responses to questions) for particular roles.

In terms of the way in which observations can be used to modify the activity’s progress, possibilities can be included in the design to have activities, acts, etc be completed when a value is set. This can be as simple as having a flag be raised when a member of a particular role sees fit (as illustrated in this example), through to more complex conditions in which average scores or numbers of users completing can trigger further events.
D.8.1.1 Activity Diagram

![Activity Diagram](image)

Figure 51: Activity diagram for “Astronomy” Scenario

D.8.2 Scenario Two: Guitar Playing for Beginners

A guitar teacher is searching through a repository, or alternatively is searching the internet looking for reusable content, concerning “guitar playing” aimed at an introductory level. S/he is looking for content that would be suitable for a self test type scenario for someone with no or little experience with guitar playing. The outcomes from the test could advise the Learner on issues related to that specific topic. The teacher finds a SCORM 1.2 package which contains various resources that s/he would like to reuse. In particular is a small five question test that seems ideal as a simple way to identify the Learner’s specific area where s/he needs guidance. The teacher wants to reuse the SCORM based test, but also tailor the questions and add different content. The teacher also wishes to model this pedagogical scenario using IMS Learning Design.

Firstly the teacher downloads the SCORM .12 archive file and unzips it. The teacher then identifies which part of the package contains the test which s/he wishes to reuse. The teacher then extracts this file along with any other files that are relevant to it. (e.g. Javascript files) The teacher edits the test or (Sharable Content Object) in a HTML editor and changes the questions to suit the new intended context for the test.
Next the teacher thinks about which roles would be needed during this course. The course will be modelled on a single user, the “learner”. The learner will progress though the Unit of Learning by him/herself. The Unit of Learning will contain seven acts. The first act serves as the placeholder for the SCORM test. A learning Activity will reside in the first act. It will instruct the user to take a test located in the Environment section. The test will have five questions, which will be able to update certain IMSLD level B properties once submitted. The properties will have conditions attached to them. Changes in conditions will allow certain acts to either “hide” or “show” feedback content, based on whether the Learner answered the question incorrectly. The user will be able to retake the test in the first act, over and over again until s/he gets all of the questions correct. Once all of the questions have been answered correctly, all other feedback will be hidden. The final act will display a new Learning Activity which will inform the Learner that all of the questions have been answered correctly and where to find further reading materials.

D.8.2.1 Activity Diagram
Figure 52: Activity diagram for “Guitar Playing for Beginners” Scenario
D.9 IMS LD Run-time Conclusions and Future Work

Future research work will concentrate on developing a generic connection protocol usable with a wider range of external tools. Currently a number of technologies have been identified as the basis for this work, including IMS Tools Interoperability, the LAMS tool contract API, the OASIS Service Provisioning Markup Language (SPML), and the Blackboard Building Blocks API. Any connection protocol needs to accomplish the key requirements of being able to launch and terminate a remote tool or service; additional requirements of monitoring, notification and intervention have also been identified.

Any proposed solution, however, also needs to address a range of related concerns, including provisioning and identity across organizational boundaries; these concerns require placing the connection protocol within a broader identity infrastructure. Identity is a key cross-cutting concern in many of the work areas of the project (e.g. repositories, client-server architecture, portfolios) and will need to be tackled in a consistent manner across the different work areas.
REFERENCES


Albanese, M. PBL: why curricula are likely to show little effect on knowledge and skills. Medical Education, vol. 34, pp. 729-738, (2000).


APPENDIX A: Problem-based Learning Scenario IMS LD Template

The XML code below presents the IMS LD representation of the problem-based learning scenario analyzed in section B.3.1 of this document.

```xml
<manifest identifier="MANIFEST-1103530-1642810-1551414">
  <organizations>
    <imsld:learning-design identifier="LD-1103530-1642810-1551414" uri="URI" level="B">
      <imsld:title>Problem-based Learning Scenario</imsld:title>
      <!-- ===== EDUCATIONAL OBJECTIVES ========================================== -->
      <imsld:learning-objectives>
        <imsld:title>Problem-based Learning Objectives</imsld:title>
        <!-- ===== TenC Taxonomy of Learning Objectives ===== -->
        <imsld:metadata>
          <imsmd:lom>
            <imsmd:classification>
              <imsmd:source>
                <imsmd:langstring>LOMv1.0</imsmd:langstring>
              </imsmd:source>
              <imsmd:value>
                <imsmd:langstring>Educational Objective</imsmd:langstring>
              </imsmd:value>
            </imsmd:purpose>
            <imsmd:taxonpath>
              <imsmd:source>
                <imsmd:langstring>TenC Learning Objectives Taxonomy - Knowledge</imsmd:langstring>
              </imsmd:source>
              <imsmd:taxon>
                <imsmd:id>4</imsmd:id>
                <imsmd:entry>
                  <imsmd:langstring>Analysis</imsmd:langstring>
                </imsmd:entry>
              </imsmd:taxon>
              <imsmd:taxon>
                <imsmd:id>5</imsmd:id>
                <imsmd:entry>
                  <imsmd:langstring>Synthesis</imsmd:langstring>
                </imsmd:entry>
              </imsmd:taxon>
              <imsmd:taxon>
                <imsmd:id>6</imsmd:id>
                <imsmd:entry>
                  <imsmd:langstring>Evaluation</imsmd:langstring>
                </imsmd:entry>
              </imsmd:taxon>
            </imsmd:taxonpath>
          </imsmd:classification>
          <imsmd:classification>
            <imsmd:source>
              <imsmd:langstring>TenC Learning Objectives Taxonomy - Skills</imsmd:langstring>
            </imsmd:source>
            < imsmd:taxon>
              <imsmd:id>2</imsmd:id>
              <imsmd:entry>
                <imsmd:langstring>Manipulation</imsmd:langstring>
              </imsmd:entry>
            </imsmd:taxon>
          </imsmd:classification>
        </imsld:metadata>
      </imsld:learning-objectives>
    </imsld:learning-design>
  </organizations>
</manifest>
```
WP6 Milestone M6.1

TenC Learning Objectives Taxonomy - Attitudes

Ten Competence – IST-2005-027087 - 241 -
TenC Learning Activities Taxonomy - Interaction

Timing

Synchronous

TenC Learning Activities Taxonomy - Assessment

Not Assessed

TenC Taxonomy of Learning Activities

Discussion on Terminology

Activity 02

---

Discussion on Terminology

---

## TenC Learning Activities Taxonomy - Interaction

### Timing

- **Synchronous**

### Assessment

- **Not Assessed**

---

TenC Taxonomy of Learning Activities

---

Discussion on Terminology

---
Discussion on Problem

<!-- ===== Activity 03 ============================================================== -->

Discussion

<!-- ===== TenC Taxonomy of Learning Activities ===== -->

Type

Discussion

Technique

Discussion

Type

Discussion

Discussion
TenC Learning Activities Taxonomy - Interaction

Medium

Online

TenC Learning Activities Taxonomy - Interaction

Timing

Synchronous

TenC Learning Activities Taxonomy - Assessment

Not Assessed

-- TenC Taxonomy of Learning Activities --
TenCompetence – IST-2005-027087 - 247 -
Assessment

TenC Learning Activities Taxonomy -

Not Assessed

TenC Learning Activities Taxonomy -

Classifying

TenC Learning Activities Taxonomy -

TenC Learning Activities Taxonomy -

Working with peers

BasicTools

CommTools

CM_Tools

Diagram

Discipline

TenC Learning Activities Taxonomy -

TenC Learning Activities Taxonomy -

TenC Learning Activities Taxonomy -

TenC Learning Activities Taxonomy -
<imsmd:entry><imsmd:langstring>Concept mapping</imsmd:langstring></imsmd:entry>

Type<imsmd:langstring>TenC Learning Activities Taxonomy - Interaction</imsmd:langstring>

Medium<imsmd:langstring>TenC Learning Activities Taxonomy - Interaction</imsmd:langstring>

Timing<imsmd:langstring>TenC Learning Activities Taxonomy - Interaction</imsmd:langstring>

Assessment<imsmd:langstring>TenC Learning Activities Taxonomy -</imsmd:langstring>

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<imsld:title>Organize into teams</imsld:title>
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<imsld:environment-ref ref="CommTools"/>
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<imsld:item identifier="Item-P1-A2-A3" identifierref="Item-P1-A2-A3"/>
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<imsld:complete-activity>
<imsld:user-choice/>
</imsld:complete-activity>
</imsld:learning-activity>
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  </imsmd:source>
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    </imsmd:entry>
  </imsmd:taxon>
</imsmd:taxonpath>

<imsmd:taxonpath>
  <imsmd:source>
    <imsmd:langstring>TenC Learning Activities Taxonomy - Assessment</imsmd:langstring>
  </imsmd:source>
  <imsmd:taxon>
    <imsmd:entry>
      <imsmd:langstring>Not Assessed</imsmd:langstring>
    </imsmd:entry>
  </imsmd:taxon>
</imsmd:taxonpath>

<!--  ===== Activity 07 ===================================================  -->
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  <imsld:title>Research</imsld:title>
  <imsld:environment-ref ref="BasicTools"/>
  <imsld:environment-ref ref="ResTools"/>
  <imsld:activity-description>
    <imsld:item identifier="Item-P1-A2-A4" identifierref="Item-P1-A2-A4"/>
  </imsld:activity-description>
  <imsld:complete-activity>
    <imsld:user-choice/>
  </imsld:complete-activity>
</imsld:learning-activity>
WP6 Milestone M6.1

Researching

TenC Learning Activities Taxonomy - Technique

Web search

TenC Learning Activities Taxonomy - Interaction Type

Group based

TenC Learning Activities Taxonomy - Interaction Medium

Online

TenC Learning Activities Taxonomy - Interaction Timing

Synchronous

TenC Learning Activities Taxonomy - Assessment

Not Assessed

-->

TenCompetence – IST-2005-027087 - 252 -
WP6 Milestone M6.1

<imsld:learning-activity identifier="P1-A2-A5" isvisible="true">
<imsld:title>Research</imsld:title>
<imsld:environment-ref ref="BasicTools"/>
<imsld:environment-ref ref="ResTools"/>
<imsld:activity-description>
<imsld:item identifier="Item-P1-A2-A5" identifierref="Item-P1-A2-A5"/>
</imsld:activity-description>
<imsld:complete-activity>
<imsld:user-choice/>
</imsld:complete-activity>
</imsld:learning-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->
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<imsmd:educational>
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</imsmd:value>
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</imsmd:source>
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Type</imsmd:langstring>
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Technique</imsmd:langstring>
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Type</imsmd:langstring>
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Group based</imsmd:entry>
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</imsmd:langstring>

TenCompetence – IST-2005-027087 - 253 -
TenC Learning Activities Taxonomy - Interaction

Medium

Online

TenC Learning Activities Taxonomy - Interaction

Timing

Synchronous

TenC Learning Activities Taxonomy -

Assessment

Not Assessed

TenC Learning Activities Taxonomy -
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  </imsmd:taxon>
</imsmd:source>

<!--  ===== Activity 10 ===================================================  -->
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  <imsld:title>Discussion with peers</imsld:title>
  <imsld:environment-ref ref="BasicTools"/>
  <imsld:environment-ref ref="CommTools"/>
  <imsld:activity-description>
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  </imsld:complete-activity>
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    </imsld:change-property-value>
  </imsld:on-completion>
</imsld:learning-activity>

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      </imsmd:learningresourcetype>
    </imsmd:educational>
    <imsmd:classification>
      <imsmd:purpose>
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        <imsmd:value>Discipline</imsmd:value>
      </imsmd:purpose>
    </imsmd:classification>
  </imsmd:lom>
</imsld:metadata>

Type

TenCompetence – IST-2005-027087 - 256 -
Peer exchange</p>

Class based</p>

Online</p>

Synchronous</p>

Formative</p>
**WP6 Milestone M6.1**

Timing</imsmd:langstring>

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</imsmd:metadatad>
</imsmd:learning-activity>
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<imsmd:environment-ref ref="BasicTools"/>
<imsmd:environment-ref ref="CommTools"/>
<imsmd:activity-description>
<imsmd:item identifier="Item-P1-A4-A1" identifierref="Item-P1-A4-A1"/>
</imsmd:activity-description>
<imsmd:complete-activity>
<imsmd:user-choice/>
</imsmd:complete-activity>
<!-- ===== TenC Taxonomy of Learning Activities ===== -->
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<imsmd:learningresourcetype>
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</imsmd:value>
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</imsmd:classification>
</imsmd:lom>
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Type</imsmd:langstring>

TenCompetence – IST-2005-027087 - 259 -
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<-- ===== ACTIVITY STRUCTURES =============================== -->
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<-- Used in Act 2 =========================================== -->
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  <imsld:learning-activity-ref ref="P1-A2-A6"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS2" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-A5"/>
  <imsld:learning-activity-ref ref="P1-A2-A6"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS3" number-to-select="1" structure-type="selection">
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  <imsld:activity-structure-ref ref="P1-A2-AS1"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS4" structure-type="sequence">
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  <imsld:learning-activity-ref ref="P1-A2-A2"/>
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  <imsld:learning-activity-ref ref="P1-A2-A2"/>
</imsld:activity-structure>

<-- Used in Act 3 =========================================== -->
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</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A3-AS2" structure-type="sequence">
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  <imsld:learning-activity-ref ref="P1-A3-A1"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A3-AS3" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-A4"/>
  <imsld:learning-activity-ref ref="P1-A2-A6"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A3-AS4" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-A5"/>
  <imsld:learning-activity-ref ref="P1-A2-A6"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A3-AS5" number-to-select="1" structure-type="selection">
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  <imsld:activity-structure-ref ref="P1-A3-AS4"/>
</imsld:activity-structure>
</imsld:activities>

<-- ===== ENVIRONMENTS ======================================= -->
<imsld:environments>
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    <imsld:title>BasicTools</imsld:title>
  </imsld:environment>
  <imsld:learning-object identifier="LO-E2-LO1">
    <imsld:title> Multimedia Viewer </imsld:title>
    <imsld:item identifier="Item-E2-LO1" identifierref="Item-E2-LO1"/>
  </imsld:learning-object>
</imsld:environments>
</imsld:learning-activity>
<imsld:act identifier="LD-Play1-Act3">
  <imsld:title>Act 3</imsld:title>
  <imsld:role-part identifier="RP-L1-P1-A3">
    <imsld:role-ref ref="L1"/>
    <imsld:activity-structure-ref ref="P1-A3-AS1"/>
  </imsld:role-part>
  <imsld:role-part identifier="RP-S1-P1-A3">
    <imsld:role-ref ref="S1"/>
    <imsld:learning-activity-ref ref="P1-A3-A1"/>
  </imsld:role-part>
</imsld:act>

<imsld:act identifier="LD-Play1-Act4">
  <imsld:title>Act 4</imsld:title>
  <imsld:role-part identifier="RP-L1-P1-A4">
    <imsld:role-ref ref="L1"/>
    <imsld:learning-activity-ref ref="P1-A4-A1"/>
  </imsld:role-part>
  <imsld:role-part identifier="RP-S1-P1-A4">
    <imsld:role-ref ref="S1"/>
    <imsld:learning-activity-ref ref="P1-A4-A1"/>
  </imsld:role-part>
</imsld:act>

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    <imsld:and>
      <imsld:is>
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        <imsld:property-value>true</imsld:property-value>
      </imsld:is>
      <imsld:is>
        <imsld:property-ref ref="Solution_Not_Fit"/>
        <imsld:property-value>true</imsld:property-value>
      </imsld:is>
    </imsld:and>
  </imsld:if>
  <imsld:then>
    <imsld:change-property-value>
      <imsld:property-ref ref="CP-P1-A3-A1"/>
      <imsld:property-value>false</ imsld:property-value>
    </imsld:change-property-value>
    <imsld:change-property-value>
      <imsld:property-ref ref="Solution_Not_Fit"/>
      <imsld:property-value>"false"
    </imsld:change-property-value>
    <imsld:show>
      <imsld:activity-structure-ref ref="P1-A3-AS2"/>
    </imsld:show>
  </imsld:then>

  <imsld:if>
    <imsld:and>
      <imsld:is>
        <imsld:property-ref ref="CP-P1-A3-A1"/>
        <imsld:property-value>true</imsld:property-value>
      </imsld:is>
      <imsld:is>
        <imsld:property-ref ref="Extra_Research"/>
        <imsld:property-value>true</imsld:property-value>
      </imsld:is>
    </imsld:and>
  </imsld:if>
  <imsld:then>
    <imsld:change-property-value>
      <imsld:property-ref ref="CP-P1-A3-A1"/>
      <imsld:property-value>false</ imsld:property-value>
    </imsld:change-property-value>
    <imsld:change-property-value>
      <imsld:property-ref ref="Extra_Research"/>
      <imsld:property-value>"false"
    </imsld:change-property-value>
    <imsld:show>
      <imsld:activity-structure-ref ref="P1-A3-AS2"/>
    </imsld:show>
  </imsld:then>
</imsld:conditions>
The above scenario template uses two complex activities, namely, the brainstorming and the research activity. The IMS LD xml representation of these activities is presented below.

<manifest identifier="MANIFEST-1141780-1852910-4134210">
  <organizations>
    <imsld:learning-design identifier="LD-1141780-1852910-4134210" uri="URI" level="B">
      <imsld:title>Brainstorming Activity</imsld:title>
      <imsld:components>
        <!-- ===== ROLES ======================================================== -->
        <imsld:roles>
          <imsld:learner identifier="L1"/>
          <imsld:title>Learner</imsld:title>
          <imsld:staff identifier="S1"/>
          <imsld:title>Tutor</imsld:title>
        </imsld:roles>
        <imsld:method>
          <imsld:learning-design>
            <imsld:conditions>
              <imsld:then>
                <imsld:if>
                  <imsld:and>
                    <imsld:is>
                      <imsld:property-ref ref="CP-P1-A3-A1"/>
                      <imsld:property-value>true</imsld:property-value>
                    </imsld:is>
                    <imsld:is-not>
                      <imsld:property-ref ref="Solution_Not_Fit"/>
                      <imsld:property-value>true</imsld:property-value>
                    </imsld:is-not>
                    <imsld:is-not>
                      <imsld:property-ref ref="Extra_Research"/>
                      <imsld:property-value>true</imsld:property-value>
                    </imsld:is-not>
                  </imsld:and>
                  <imsld:then>
                    <imsld:change-property-value>
                      <imsld:property-ref ref="CP-P1-A3-A1"/>
                      <imsld:property-value>false</imsld:property-value>
                    </imsld:change-property-value>
                    <imsld:show>
                      <imsld:activity-structure-ref ref="P1-A3-AS5"/>
                    </imsld:show>
                  </imsld:then>
                </imsld:if>
              </imsld:then>
              <imsld:conditions>
                <imsld:then>
                  <imsld:if>
                    <imsld:and>
                      <imsld:is>
                        <imsld:property-ref ref="CP-P1-A3-A1"/>
                        <imsld:property-value>true</imsld:property-value>
                      </imsld:is>
                      <imsld:is-not>
                        <imsld:property-ref ref="Solution_Not_Fit"/>
                        <imsld:property-value>true</imsld:property-value>
                      </imsld:is-not>
                      <imsld:is-not>
                        <imsld:property-ref ref="Extra_Research"/>
                        <imsld:property-value>true</imsld:property-value>
                      </imsld:is-not>
                    </imsld:and>
                    <imsld:then>
                      <imsld:change-property-value>
                        <imsld:property-ref ref="CP-P1-A3-A1"/>
                        <imsld:property-value>false</imsld:property-value>
                      </imsld:change-property-value>
                      <imsld:show>
                        <imsld:activity-structure-ref ref="P1-A3-AS5"/>
                      </imsld:show>
                    </imsld:then>
                  </imsld:if>
                </imsld:then>
              </imsld:conditions>
            </imsld:learning-design>
          </imsld:show>
        </imsld:roles>
      </imsld:components>
    </imsld:learning-design>
  </organizations>
</manifest>
<!-==== PROPERTIES =============================== -->
<imsld:properties>
  <imsld:locpers-property identifier="CP-P1-A3-A1">
    <imsld:datatype datatype="boolean"/>
    <imsld:initial-value>false</imsld:initial-value>
  </imsld:locpers-property>
  <imsld:loc-property identifier="Consensus_Not_Achieved">
    <imsld:datatype datatype="boolean"/>
    <imsld:initial-value>false</imsld:initial-value>
  </imsld:loc-property>
</imsld:properties>

<!-==== ACTIVITIES =============================== -->
<!-==== Activity 01 =============================== -->
<imsld:activities>
    <imsld:title>Issue</imsld:title>
    <imsld:environment-ref ref="BasicTools"/>
    <imsld:activity-description>
    </imsld:activity-description>
    <imsld:complete-activity>
      <imsld:user-choice/>
    </imsld:complete-activity>
    <!-- ===== TenC Taxonomy of Learning Activities ===== -->
    <imsld:metadata>
      <imsmd:lom>
        <imsmd:educational>
          <imsmd:learningresourcetype>
            <imsmd:source>
              <imsmd:langstring>LOMv1.0</imsmd:langstring>
            </imsmd:source>
            <imsmd:value>
              <imsmd:langstring>NarrativeText</imsmd:langstring>
            </imsmd:value>
          </imsmd:learningresourcetype>
        </imsmd:educational>
        <imsmd:classification>
          <imsmd:purpose>
            <imsmd:source>
              <imsmd:langstring>LOMv1.0</imsmd:langstring>
            </imsmd:source>
            <imsmd:value>
              <imsmd:langstring>Discipline</imsmd:langstring>
            </imsmd:value>
          </imsmd:purpose>
          <imsmd:taxonpath>
            <imsmd:source>
              <imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
            </imsmd:source>
          </imsmd:taxonpath>
        </imsmd:classification>
        <imsmd:taxonpath>
          <imsmd:source>
            <imsmd:langstring>TenC Learning Activities Taxonomy - Technique</imsmd:langstring>
          </imsmd:source>
        </imsmd:taxonpath>
      </imsmd:lom>
    </imsld:metadata>
</imsld:activities>
Type <imsmd:langstring>Individual</imsmd:langstring>

Medium <imsmd:langstring>Online</imsmd:langstring>

Timing <imsmd:langstring>Synchronous</imsmd:langstring>

Assessment <imsmd:langstring>Not Assessed</imsmd:langstring>

---

WP6 Milestone M6.1

TenCompetence – IST-2005-027087 - 266 -
WP6 Milestone M6.1

Timing

TenC Learning Activities Taxonomy - Interaction

<imsmd:source>
<imsmd:langstring>Synchronous</imsmd:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:source>

Assessment

TenC Learning Activities Taxonomy -

<imsmd:source>
<imsmd:langstring>Not Assessed</imsmd:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
</imsld:learning-activity>

Activity 03

TenC Learning Activities Taxonomy -

<imsld:learning-activity identifier="P1-A2-A1" isvisible="true">
<imsld:title>Working together and discuss</imsld:title>
<imsld:environment-ref ref="BasicTools"/>
<imsld:environment-ref ref="CommTools"/>
<imsld:environment-ref ref="CM_Tools"/>
<imsld:activity-description>
<imsld:item identifier="Item-P1-A2-A1" identifierref="Item-P1-A2-A1"/>
</imsld:activity-description>
</imsld:complete-activity>
</imsld:metadata>
</imsmd:lom>
</imsmd:educational>
</imsmd:learningresourcetype>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Spreadsheet</imsmd:langstring>
</imsmd:value>
</imsmd:learningresourcetype>
</imsmd:classification>
</imsmd:purpose>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Discipline</imsmd:langstring>
</imsmd:value>
</imsmd:purpose>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy -

Type

TenC Learning Activities Taxonomy -

<imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsmd:langstring>Practicing</imsmd:langstring> TenC Learning Activities Taxonomy -

Technique</imsmd:langstring> TenC Learning Activities Taxonomy - Interaction

Type</imsmd:langstring> TenC Learning Activities Taxonomy - Interaction

Medium</imsmd:langstring> TenC Learning Activities Taxonomy - Interaction

Timing</ imsmd:langstring> TenC Learning Activities Taxonomy -

Assessment</ imsmd:langstring> TenC Learning Activities Taxonomy -
<imsd:title>Revise initial ideas</imsd:title>
<imsd:environment-ref ref="BasicTools"/>
<imsd:environment-ref ref="CommTools"/>
<imsd:activity-description>
  <imsd:item identifier="Item-P1-A2-A2" identifierref="Item-P1-A2-A2"/>
</imsd:activity-description>
<imsd:complete-activity>
  <imsd:user-choice/>
</imsd:complete-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->
<imsd:metadata>
  <imsmd:lom>
    <imsmd:educational>
      <imsmd:learningresourcetype>
        <imsmd:source>
          <imsmd:langstring>LOMv1.0</imsmd:langstring>
        </imsmd:source>
        <imsmd:value>
          <imsmd:langstring>Diagram</imsmd:langstring>
        </imsmd:value>
      </imsmd:learningresourcetype>
    </imsmd:educational>
    <imsmd:classification>
      <imsmd:purpose>
        <imsmd:source>
          <imsmd:langstring>LOMv1.0</imsmd:langstring>
        </imsmd:source>
        <imsmd:value>
          <imsmd:langstring>Discipline</imsmd:langstring>
        </imsmd:value>
      </imsmd:purpose>
      <imsmd:taxonpath>
        <imsmd:source>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
        </imsmd:source>
        <imsmd:taxon>
          <imsmd:entry>
            <imsmd:langstring>Debating</imsmd:langstring>
          </imsmd:entry>
        </imsmd:taxon>
      </imsmd:taxonpath>
      <imsmd:taxonpath>
        <imsmd:source>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Technique</imsmd:langstring>
        </imsmd:source>
        <imsmd:taxon>
          <imsmd:entry>
            <imsmd:langstring>Negotiation</imsmd:langstring>
          </imsmd:entry>
        </imsmd:taxon>
      </imsmd:taxonpath>
      <imsmd:taxonpath>
        <imsmd:source>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Interaction Type</imsmd:langstring>
        </imsmd:source>
        <imsmd:taxon>
          <imsmd:entry>
            <imsmd:langstring>Class based</imsmd:langstring>
          </imsmd:entry>
        </imsmd:taxon>
      </imsmd:taxonpath>
    </imsmd:classification>
  </imsmd:lom>
</imsd:metadata>
TenC Learning Activities Taxonomy - Interaction

Medium

- Online

TenC Learning Activities Taxonomy - Interaction

Timing

- Synchronous

TenC Learning Activities Taxonomy - Assessment

- Not Assessed
TenCompetence – IST-2005-027087 - 272 -
TenC Learning Activities Taxonomy - Assessment

Not Assessed
<ims:act identifier="LD-Play1-Act1">
  <ims:title>Act 1</ims:title>
  <ims:role-part identifier="RP-L1-P1-A1">
    <ims:role-ref ref="L1"/>
    <ims:activity-structure-ref ref="P1-A1-AS1"/>
  </ims:role-part>
  <ims:role-part identifier="RP-S1-P1-A1">
    <ims:role-ref ref="S1"/>
  </ims:role-part>
</ims:act>

<ims:act identifier="LD-Play1-Act2">
  <ims:title>Act 2</ims:title>
  <ims:role-part identifier="RP-L1-P1-A2">
    <ims:role-ref ref="L1"/>
    <ims:activity-structure-ref ref="P1-A2-AS1"/>
  </ims:role-part>
  <ims:role-part identifier="RP-S1-P1-A2">
    <ims:role-ref ref="S1"/>
    <ims:activity-structure-ref ref="P1-A2-A1"/>
  </ims:role-part>
</ims:act>

<ims:act identifier="LD-Play1-Act3">
  <ims:title>Act 3</ims:title>
  <ims:role-part identifier="RP-L1-P1-A3">
    <ims:role-ref ref="L1"/>
    <ims:activity-structure-ref ref="P1-A3-AS1"/>
  </ims:role-part>
  <ims:role-part identifier="RP-S1-P1-A3">
    <ims:role-ref ref="S1"/>
    <ims:learning-activity-ref ref="P1-A3-A1"/>
  </ims:role-part>
</ims:act>

<!--  ===== CONDITIONS ===================================================  -->
<ims:conditions>
  <ims:if>
    <ims:and>
      <ims:is>
        <ims:property-ref ref="CP-P1-A3-A1"/>
        <ims:property-value>true</ims:property-value>
      </ims:is>
      <ims:is>
        <ims:property-ref ref="Consensus_Not_Achieved"/>
        <ims:property-value>true</ims:property-value>
      </ims:is>
    </ims:and>
  </ims:if>
  <ims:then>
    <ims:change-property-value>
      <ims:property-ref ref="CP-P1-A3-A1"/>
      <ims:property-value>false</ims:property-value>
    </ims:change-property-value>
    <ims:change-property-value>
      <ims:property-ref ref="Consensus_Not_Achieved"/>
      <ims:property-value>"false"</ims:property-value>
    </ims:change-property-value>
    <ims:show>
      <ims:activity-structure-ref ref="P1-A3-AS1"/>
    </ims:show>
  </ims:then>
</ims:conditions>
</ims:method>
<manifest identifier="MANIFEST-4823173-3569013-6122745">
  <organizations />
  <resources />
</manifest>

<manifest identifier="MANIFEST-4823173-3569013-6122745">
  <imsld:learning-design identifier="LD-4823173-3569013-6122745" uri="URI" level="B">
    <imsld:title>Research Activity</imsld:title>
    <imsld:components>
      <!-- ===== ROLES ======================================================== -->
      <imsld:roles>
        <imsld:learner identifier="L1">
          <imsld:title>Learner</imsld:title>
        </imsld:learner>
        <imsld:staff identifier="S1">
          <imsld:title>Tutor</imsld:title>
        </imsld:staff>
      </imsld:roles>

      <!-- ===== PROPERTIES =================================================== -->
      <imsld:properties>
        <imsld:locpers-property identifier="CP-P1-A2-A1">
          <imsld:datatype datatype="boolean"/>
          <imsld:initial-value>false</imsld:initial-value>
        </imsld:locpers-property>
        <imsld:loc-property identifier="Negative_Feedback">
          <imsld:datatype datatype="boolean"/>
          <imsld:initial-value>false</imsld:initial-value>
        </imsld:loc-property>
      </imsld:properties>

      <!-- ===== ACTIVITIES ===================================================== -->
      <!-- ===== Activity 01 ====================================================== -->
      <imsld:activities>
          <imsld:title>Issue to be resolved</imsld:title>
          <imsld:environment-ref ref="BasicTools"/>
          <imsld:activity-description>
          </imsld:activity-description>
          <imsld:complete-activity>
            <imsld:user-choice/>
          </imsld:complete-activity>
        </imsld:learning-activity>
        <imsmd:lom>
          <imsmd:learningresourcetype>
            <imsmd:source>
              <imsmd:langstring>LOMv1.0</imsmd:langstring>
            </imsmd:source>
          </imsmd:learningresourcetype>
          <imsmd:classification>
            <imsmd:purpose>
              <imsmd:source>
                <imsmd:langstring>LOMv1.0</imsmd:langstring>
              </imsmd:source>
            </imsmd:purpose>
            <imsmd:educational/>
          </imsmd:classification>
        </imsmd:lom>
      </imsld:activities>
    </imsld:learning-design>
  </organizations>
</manifest>
Type

- Presenting
- Presentation
- Group based
- Online
- Synchronous
- Not Assessed
WP6 Milestone M6.1

<imsld:learning-activity identifier="P1-A1-A2" isvisible="true">
  <imsld:title>Gather Data</imsld:title>
  <imsld:environment-ref ref="BasicTools"/>
  <imsld:environment-ref ref="CommTools"/>
  <imsld:environment-ref ref="ResTools"/>
  <imsld:activity-description>
    <imsld:item identifier="Item-P1-A1-A2" identifierref="Item-P1-A1-A2"/>
  </imsld:activity-description>
</imsld:learning-activity>

<imsld:metadata>
  <imsmd:lom>
    <imsmd:educational>
      <imsmd:learningresourcetype>
        <imsmd:source>
          <imsmd:langstring>LOMv1.0</imsmd:langstring>
        </imsmd:source>
        <imsmd:value>
          <imsmd:langstring>Spreadsheet</imsmd:langstring>
        </imsmd:value>
      </imsmd:learningresourcetype>
    </imsmd:educational>
    <imsmd:classification>
      <imsmd:purpose>
        <imsmd:source>
          <imsmd:langstring>LOMv1.0</imsmd:langstring>
        </imsmd:source>
        <imsmd:value>
          <imsmd:langstring>Discipline</imsmd:langstring>
        </imsmd:value>
      </imsmd:purpose>
      <imsmd:taxonpath>
        <imsmd:source>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
        </imsmd:source>
        <imsmd:taxon>
          <imsmd:entry>Gathering</imsmd:entry>
        </imsmd:taxon>
      </imsmd:taxonpath>
    </imsmd:classification>
    <imsmd:classification>
      <imsmd:purpose>
        <imsmd:source>
          <imsmd:langstring>LOMv1.0</imsmd:langstring>
        </imsmd:source>
        <imsmd:value>
          <imsmd:langstring>Technique</imsmd:langstring>
        </imsmd:value>
      </imsmd:purpose>
      <imsmd:taxonpath>
        <imsmd:source>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Technique</imsmd:langstring>
        </imsmd:source>
        <imsmd:taxon>
          <imsmd:entry>Web Search</imsmd:entry>
        </imsmd:taxon>
      </imsmd:taxonpath>
    </imsmd:classification>
  </imsmd:lom>
</imsld:metadata>
WP6 Milestone M6.1

TenC Learning Activities Taxonomy - Interaction

Type

Group based

TenC Learning Activities Taxonomy - Interaction

Medium

Online

TenC Learning Activities Taxonomy - Interaction

Timing

Synchronous

TenC Learning Activities Taxonomy - Interaction

Assessment

Not Assessed

TenC Learning Activities Taxonomy -

Activity 03

Select and Organize Data

TenC Taxonomy of Learning Activities

Identifiers: P1-A1-A3
<imsmd:entry>Synchronous</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
<imsmd:source>TenC Learning Activities Taxonomy - Assessment</imsmd:source>
<imsmd:taxon>
<imsmd:entry>Not Assessed</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
</imsld:learning-activity>

<!--  ===== Activity 04 ===================================================  -->
<imsld:learning-activity identifier="P1-A1-A4" isvisible="true">
<imsld:title>Report</imsld:title>
<imsld:environment-ref ref="BasicTools"/>
<imsld:environment-ref ref="CommTools"/>
<imsld:environment-ref ref="CollabTool"/>
<imsld:activity-description>
</imsld:activity-description>
<imsld:complete-activity>
<imsld:user-choice/>
</imsld:complete-activity>
</imsld:learning-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->
<imsld:metadata>
<imsmd:lom>
<imsmd:educational>
<imsmd:learningresourcetype>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Table</imsmd:langstring>
</imsmd:value>
</imsmd:learningresourcetype>
</imsmd:educational>
<imsmd:classification>
<imsmd:purpose>
<imsmd:source>
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</imsmd:source>
<imsmd:value>
<imsmd:langstring>Discipline</imsmd:langstring>
</imsmd:value>
</imsmd:purpose>
<imsmd:taxonpath>
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<imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
</imsmd:source>
<imsmd:entry>Analyzing</imsmd:entry>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
WP6 Milestone M6.1

TenCompetence – IST-2005-027087 - 282 -

TenC Taxonomy of Learning Activities

Type:

- Discussing
- Articulate reasoning
- Group based

Technique:

- TenC Learning Activities Taxonomy -
- TenC Learning Activities Taxonomy - Interaction

Medium:
WP6 Milestone M6.1

TenC Learning Activities Taxonomy - Interaction

Timing

TenC Learning Activities Taxonomy - Assessment

Not Assessed

Activity 06

Answer big picture question

TenC Taxonomy of Learning Activities
TenC Learning Activities Taxonomy - Interaction

Type</imsmd:langstring>
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</imsmd:taxonpath>

TenC Learning Activities Taxonomy - Interaction

Medium</imsmd:langstring>
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</imsmd:taxon>
</imsmd:taxonpath>

TenC Learning Activities Taxonomy - Interaction

Timing</imsmd:langstring>
</imsmd:source>
</imsmd:taxon>
</imsmd:taxonpath>

TenC Learning Activities Taxonomy -

Assessment</imsmd:langstring>
</imsmd:source>
</imsmd:taxon>
</imsmd:taxonpath>

TenC Learning Activities Taxonomy -

<imsld:metadata>
</imsld:metadata>
</imsld:learning-activity>

<imsld:learning-activity identifier="P1-A2-A2" isvisible="false">
<imsld:title>Research</imsld:title>
<imsld:environment-ref ref="BasicTools"/>
<imsld:environment-ref ref="CommTools"/>
<imsld:environment-ref ref="CollabTool"/>
<imsld:activity-description>
<imsld:item identifier="Item-P1-A2-A2" identifierref="Item-P1-A2-A2"/>
</imsld:activity-description>
</imsld:complete-activity>
</imsld:learning-activity>

TenC Taxonomy of Learning Activities
WP6 Milestone M6.1

<TenCompetence>

<imsmd:lom>
<imsmd:educational>
<imsmd:learningresourcetype>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Table</imsmd:langstring>
</imsmd:value>
</imsmd:learningresourcetype>
<imsmd:classification>
<imsmd:purpose>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Discipline</imsmd:langstring>
</imsmd:value>
</imsmd:purpose>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
</imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsmd:langstring>Producing</imsmd:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy - Technique</imsmd:langstring>
</imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsmd:langstring>Artifact</imsmd:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy - Interaction Type</imsmd:langstring>
</imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsmd:langstring>Group based</imsmd:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy - Interaction Medium</imsmd:langstring>
</imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsmd:langstring>Online</imsmd:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:educational>
</imsmd:lom>

TenCompetence – IST-2005-027087 - 287 -
TenC Learning Activities Taxonomy - Interaction

Timing

Synchronous

TenC Learning Activities Taxonomy - Assessment

Not Assessed

---

activity-structure identifier="P1-A1-AS1" structure-type="sequence">
</imsld:activity-structure>
</imsld:activity-structure>

---

activity-structure identifier="P1-A2-AS1" structure-type="sequence">
<imsld:learning-activity-ref ref="P1-A2-A1"/>
</imsld:activity-structure>
</imsld:activity-structure>
</imsld:activities>

---

environments>
<imsld:environment identifier="BasicTools">
<imsld:title>BasicTools</imsld:title>
<imsld:learning-object identifier="LO-E2-LO1">
<imsld:title>Multimedia Viewer</imsld:title>
<imsld:item identifier="Item-E2-LO1" identifierref="Item-E2-LO1"/>
</imsld:learning-object>
</imsld:environment>
<imsld:environment identifier="CommTools">
<imsld:title>Communication Tools</imsld:title>
<imsld:learning-object identifier="LO-E3-LO1">
<imsld:title>Discussion Board</imsld:title>
<imsld:item identifier="Item-E3-LO1" identifierref="Item-E3-LO1"/>
</imsld:learning-object>
<imsld:learning-object identifier="LO-E3-LO2">
<imsld:title>Instant Messaging</imsld:title>
<imsld:item identifier="Item-E3-LO2" identifierref="Item-E3-LO2"/>
</imsld:learning-object>
</imsld:environment>
</imsld:environments>
APPENDIX B: Project-based Learning Scenario IMS LD Template

The XML code below presents the IMS LD representation of the project-based learning scenario analyzed in section B.3.2 of this document.

```xml
<manifest identifier="MANIFEST-6732173-8426412-3427801">
  <organizations>
    <imsld:learning-design identifier="LD-6732173-8426412-3427801" uri="URI" level="B">
      <imsld:title>Project-based Learning Scenario</imsld:title>
      <imsld:learning-objectives>
        <imsld:title>Project-based Learning Objectives</imsld:title>
        <imsld:metadata>
          <imsmd:lom>
            <imsmd:classification>
              <imsmd:source>
                <imsmd:langstring>LOMv1.0</imsmd:langstring>
              </imsmd:source>
              <imsmd:value>
                <imsmd:langstring>Educational Objective</imsmd:langstring>
              </imsmd:value>
              <imsmd:taxonpath>
                <imsmd:taxon>
                  <imsmd:id>2</imsmd:id>
                  <imsmd:entry>
                    <imsmd:langstring>Comprehension</imsmd:langstring>
                  </imsmd:entry>
                </imsmd:taxon>
                <imsmd:taxon>
                  <imsmd:id>3</imsmd:id>
                  <imsmd:entry>
                    <imsmd:langstring>Application</imsmd:langstring>
                  </imsmd:entry>
                </imsmd:taxon>
                <imsmd:taxon>
                  <imsmd:id>4</imsmd:id>
                  <imsmd:entry>
                    <imsmd:langstring>Analysis</imsmd:langstring>
                  </imsmd:entry>
                </imsmd:taxon>
                <imsmd:taxon>
                  <imsmd:id>5</imsmd:id>
                  <imsmd:entry>
                    <imsmd:langstring>Synthesis</imsmd:langstring>
                  </imsmd:entry>
                </imsmd:taxon>
                <imsmd:taxon>
                  <imsmd:id>6</imsmd:id>
                  <imsmd:entry>
                    <imsmd:langstring>Evaluation</imsmd:langstring>
                  </imsmd:entry>
                </imsmd:taxon>
              </imsmd:taxonpath>
              <imsmd:taxonpath>
                <imsmd:taxon>
                  <imsmd:id>1</imsmd:id>
                  <imsmd:entry>
                    <imsmd:langstring>TenC Learning Objectives Taxonomy - Knowledge</imsmd:langstring>
                  </imsmd:entry>
                </imsmd:taxon>
              </imsmd:taxonpath>
            </imsmd:source>
          </imsmd:lom>
        </imsld:metadata>
        <!-- ===== EDUCATIONAL OBJECTIVES ========================================== -->
      </imsld:learning-objectives>
    </imsld:learning-design>
  </organizations>
</manifest>
```
TenC Learning Objectives Taxonomy - Skills

- Precision
- Articulation

TenC Learning Objectives Taxonomy - Attitudes

- Receiving
- Responding
- Valuing
- Organization
Analysing

TenC Learning Activities Taxonomy - Technique

Concept Mapping

TenC Learning Activities Taxonomy - Interaction Type

Group based

TenC Learning Activities Taxonomy - Interaction Medium

Online

TenC Learning Activities Taxonomy - Interaction Timing

Synchronous

TenC Learning Activities Taxonomy - Assessment

Summative
<imsld:learning-activity identifier="P1-A1-A2" isvisible="true">
  <imsld:title>Project Plan Definition</imsld:title>
  <imsld:environment-ref ref="BasicTools"/>
  <imsld:environment-ref ref="CommTools"/>
  <imsld:environment-ref ref="ManagTools"/>
  <imsld:activity-description>
    <imsld:activity-description>
      <imsid:complete-activity>
        <imsld:user-choice/>
      </imsld:complete-activity>
    </imsld:activity-description>
  </imsld:activity-description>
</imsld:learning-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->
<imsmd:metadata>
  <imsmd:lom>
    <imsmd:educational>
      <imsmd:learningresourcetype>
        <imsmd:source>
          <imsmd:value>
            <imsmd:langstring>LOMv1.0</imsmd:langstring>
          </imsmd:value>
        </imsmd:source>
      </imsmd:learningresourcetype>
    </imsmd:educational>
    <imsmd:classification>
      <imsmd:purpose>
        <imsmd:source>
          <imsmd:value>
            <imsmd:langstring>Discipline</imsmd:langstring>
          </imsmd:value>
        </imsmd:source>
      </imsmd:purpose>
    </imsmd:classification>
    <imsmd:taxonpath>
      <imsmd:source>
        <imsmd:value>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
        </imsmd:value>
      </imsmd:source>
      <imsmd:taxon>
        <imsmd:entry>
          Negotiating
        </imsmd:entry>
      </imsmd:taxon>
    </imsmd:taxonpath>
  </imsmd:lom>
  <imsmd:lom>
    <imsmd:educational>
      <imsmd:learningresourcetype>
        <imsmd:source>
          <imsmd:value>
            <imsmd:langstring>LOMv1.0</imsmd:langstring>
          </imsmd:value>
        </imsmd:source>
      </imsmd:learningresourcetype>
    </imsmd:educational>
    <imsmd:classification>
      <imsmd:purpose>
        <imsmd:source>
          <imsmd:value>
            <imsmd:langstring>Discipline</imsmd:langstring>
          </imsmd:value>
        </imsmd:source>
      </imsmd:purpose>
    </imsmd:classification>
    <imsmd:taxonpath>
      <imsmd:source>
        <imsmd:value>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Technique</imsmd:langstring>
        </imsmd:value>
      </imsmd:source>
      <imsmd:taxon>
        <imsmd:entry>
          Coaching
        </imsmd:entry>
      </imsmd:taxon>
    </imsmd:taxonpath>
  </imsmd:lom>
  <imsmd:lom>
    <imsmd:educational>
      <imsmd:learningresourcetype>
        <imsmd:source>
          <imsmd:value>
            <imsmd:langstring>LOMv1.0</imsmd:langstring>
          </imsmd:value>
        </imsmd:source>
      </imsmd:learningresourcetype>
    </imsmd:educational>
    <imsmd:classification>
      <imsmd:purpose>
        <imsmd:source>
          <imsmd:value>
            <imsmd:langstring>Discipline</imsmd:langstring>
          </imsmd:value>
        </imsmd:source>
      </imsmd:purpose>
    </imsmd:classification>
    <imsmd:taxonpath>
      <imsmd:source>
        <imsmd:value>
          <imsmd:langstring>TenC Learning Activities Taxonomy - Interaction Type</imsmd:langstring>
        </imsmd:value>
      </imsmd:source>
      <imsmd:taxon>
        <imsmd:entry>
          Group based
        </imsmd:entry>
      </imsmd:taxon>
    </imsmd:taxonpath>
  </imsmd:lom>
</imsmd:metadata>
TenC Learning Activities Taxonomy - Interaction

Medium

- Online

TenC Learning Activities Taxonomy - Interaction

Timing

- Synchronous

TenC Learning Activities Taxonomy - Assessment

- Not Assessed

-------- Activity 03 ----------------------------------------------- -->

<ims:title>Execute</ims:title>
<ims:environment-ref ref="BasicTools"/>
<ims:environment-ref ref="CommTools"/>
<ims:activity-description>
</ims:activity-description>
<ims:complete-activity/>
<ims:metadata>
<ims:lom>
<ims:classification>
<ims:purpose>
TenCompetence – IST-2005-027087 - 296 -
WP6 Milestone M6.1

TenCompetence – IST-2005-027087 - 297 -
Assessment</imsmd:langstring> TenC Learning Activities Taxonomy -
</imsmd:source>
</imsmd:taxon>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
</imsld:learning-activity>

<!-- ===== Activity 04 ================================================== -->
<imsld:learning-activity identifier="P1-A1-A4" isvisible="true">
<imsld:title>Execute</imsld:title>
<imsld:environment-ref ref="BasicTools"/>
<imsld:environment-ref ref="CommTools"/>
<imsld:environment-ref ref="CollabTool"/>
<imsld:activity-description>
</imsld:activity-description>
<imsld:complete-activity>
<imsld:user-choice/>
</imsld:complete-activity>
</imsld:learning-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->
<imsld:metadata>
<imsmd:lom>
<imsmd:educational>
<imsmd:learningresourcetype>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Spreadsheet</imsmd:langstring>
</imsmd:value>
</imsmd:learningresourcetype>
</imsmd:educational>
</imsmd:classification>
<imsmd:purpose>
<imsmd:source>
<imsmd:langstring>LOMv1.0</imsmd:langstring>
</imsmd:source>
<imsmd:value>
<imsmd:langstring>Discipline</imsmd:langstring>
</imsmd:value>
</imsmd:purpose>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy - Type</imsmd:langstring>
</imsmd:source>
</imsmd:taxonpath>
<imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy - Technique</imsmd:langstring>
</imsmd:source>
</imsmd:taxonpath>
<imsmd:source>
<imsmd:langstring>TenC Learning Activities Taxonomy -
</imsmd:source>
</imsmd:taxon>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
Artifact

WP6 Milestone M6.1

Type

Medium

Timing

Assessment
TenC Learning Activities Taxonomy - Interaction

Timing

Synchronous

TenC Learning Activities Taxonomy - Assessment

Formative

TenCompetence – IST-2005-027087 - 301 -
TenCompetence – IST-2005-027087 - 302 -
<imsld:learning-activity identifier="P1-A2-A1" isvisible="true">
  <imsld:title>Discussion with peers</imsld:title>
  <imsld:environment-ref ref="BasicTools"/>
  <imsld:environment-ref ref="CommTools"/>
  <imsld:activity-description>
    <imsld:item identifier="Item-P1-A2-A1" identifierref="Item-P1-A2-A1"/>
  </imsld:activity-description>
</imsld:learning-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->

<imsmd:taxonpath>
  <imsmd:source>TenC Learning Activities Taxonomy - Type</imsmd:source>
  <imsmd:entry>Discussing</imsmd:entry>
</imsmd:taxonpath>

<imsmd:taxonpath>
  <imsmd:source>TenC Learning Activities Taxonomy - Technique</imsmd:source>
  <imsmd:entry>Peer exchange</imsmd:entry>
</imsmd:taxonpath>
<imsmd:taxonpath>
  <imsmd:source>TenC Learning Activities Taxonomy - Interaction</imsmd:source>
  <imsmd:taxon>
    <imsmd:entry>Group based</imsmd:entry>
  </imsmd:taxon>
</imsmd:taxonpath>

<imsmd:taxonpath>
  <imsmd:source>TenC Learning Activities Taxonomy - Interaction</imsmd:source>
  <imsmd:taxon>
    <imsmd:entry>Online</imsmd:entry>
  </imsmd:taxon>
</imsmd:taxonpath>

<imsmd:taxonpath>
  <imsmd:source>TenC Learning Activities Taxonomy - Interaction</imsmd:source>
  <imsmd:taxon>
    <imsmd:entry>Synchronous</imsmd:entry>
  </imsmd:taxon>
</imsmd:taxonpath>

<imsmd:taxonpath>
  <imsmd:source>TenC Learning Activities Taxonomy - Assessment</imsmd:source>
  <imsmd:taxon>
    <imsmd:entry>Not Assessed</imsmd:entry>
  </imsmd:taxon>
</imsmd:taxonpath>

<!--  ===== Activity 08 ===================================================  -->
<imsld:learning-activity identifier="P1-A2-A2" isvisible="false">
  <imsld:title>Assessment</imsld:title>
  <imsld:environment-ref ref="BasicTools"/>
  <imsld:environment-ref ref="CM_Tools"/>
  <imsld:activity-description>
    <imsld:item identifier="Item-P1-A2-A2" identifierref="Item-P1-A2-A2"/>
  </imsld:activity-description>
  <imsld:complete-activity>
    <imsld:user-choice/>
  </imsld:complete-activity>
</imsld:learning-activity>
WP6 Milestone M6.1

<imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsm:langstring>Synchronous</imsm:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
<imsmd:taxonpath>
<imsmd:source>
<imsm:langstring>TenC Learning Activities Taxonomy - Assessment</imsm:langstring>
</ imsmd:source>
<imsmd:taxon>
<imsmd:entry>
<imsm:langstring>Summative</imsm:langstring>
</imsmd:entry>
</imsmd:taxon>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
</imsld:learning-activity>

<!--  ===== Activity 09 ===================================================  -->
<imsld:learning-activity identifier="P1-A2-A3" isvisible="true">
<imsld:title>Project outcomes presentation</imsld:title>
<imsld:environment-ref ref="BasicTools"/>
<imsld:environment-ref ref="CommTools"/>
<imsld:activity-description>
<imsld:item identifier="Item-P1-A2-A3" identifierref="Item-P1-A2-A3"/>
</imsld:activity-description>
<imsld:complete-activity>
<imsld:user-choice/>
</imsld:complete-activity>
</imsld:learning-activity>

<!-- ===== TenC Taxonomy of Learning Activities ===== -->
<imsld:metadata>
<imsmd:lom>
<imsmd:educational>
<imsmd:learningresourcetype>
<imsmd:source>
<imsm:langstring>LOMv1.0</imsm:langstring>
</imsmd:source>
<imsmd:value>
<imsm:langstring>Diagram</imsm:langstring>
</imsmd:value>
</imsmd:learningresourcetype>
</imsmd:educational>
<imsmd:classification>
<imsmd:purpose>
<imsmd:source>
<imsm:langstring>LOMv1.0</imsm:langstring>
</imsmd:source>
<imsmd:value>
<imsm:langstring>Discipline</imsm:langstring>
</imsmd:value>
</imsmd:purpose>
<imsmd:taxonpath>
<imsmd:source>
<imsm:langstring>TenC Learning Activities Taxonomy - Type</imsm:langstring>
</imsmd:source>
</imsmd:taxonpath>
</imsmd:classification>
</imsmd:lom>
</imsld:metadata>
TenCompetence – IST-2005-027087

---

**WP6 Milestone M6.1**

**Technique**

TenC Learning Activities Taxonomy - Technique

- **Presentation**

**Type**

TenC Learning Activities Taxonomy - Interaction Type

- **Class based**

**Medium**

TenC Learning Activities Taxonomy - Interaction Medium

- **Online**

**Timing**

TenC Learning Activities Taxonomy - Interaction Timing

- **Synchronous**

**Assessment**

TenC Learning Activities Taxonomy - Assessment

- **Not Assessed**

---

**Activity 10**

Discussion and Feedback

- **BasicTools**
- **CommTools**

---

TenC Learning Activities Taxonomy - Activity 10
<imsid:activity-description>
  <imsid:item identifier="Item-P1-A3-A1" identifierref="Item-P1-A3-A1"/>
</imsid:activity-description>
<imsid:complete-activity>
  <imsid:user-choice/>
</imsid:complete-activity>
</imsid:metadata>
</imsmd:lom>

---

TenC Taxonomy of Learning Activities

- **Type**: Critiquing
- **Technique**: Articulate reasoning
- **Type**: Class based

---

TenCompetence – IST-2005-027087
TenC Learning Activities Taxonomy - Interaction

TenC Learning Activities Taxonomy - Assessment

---

Activity Structures

P1-A1-AS1

P1-A1-AS2

P1-A1-AS3

P1-A1-AS4

P1-A1-AS5

---

Used in Act 1

Used in Act 2

---
<imsld:activity-structure identifier="P1-A2-AS2" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-A1"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS3" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-A1"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS4" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-A1"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS5" number-to-select="1" structure-type="selection">
  <imsld:activity-structure-ref ref="P1-A2-AS4"/>
  <imsld:activity-structure-ref ref="P1-A2-AS3"/>
</imsld:activity-structure>

<imsld:activity-structure identifier="P1-A2-AS6" structure-type="sequence">
  <imsld:learning-activity-ref ref="P1-A2-AS5"/>
</imsld:activity-structure>

<!--  ===== ENVIRONMENTS ================================================  -->
<imsld:environments>
  <imsld:environment identifier="BasicTools">
    <imsld:title>BasicTools</imsld:title>
    <imsld:learning-object identifier="LO-E2-LO1">
      <imsld:title>Multimedia Viewer</imsld:title>
      <imsld:item identifier="Item-E2-LO1" identifierref="Item-E2-LO1"/>
    </imsld:learning-object>
  </imsld:environment>

  <imsld:environment identifier="CommTools">
    <imsld:title>CommunicationTools</imsld:title>
    <imsld:learning-object identifier="LO-E3-LO1">
      <imsld:title>Discussion Board</imsld:title>
      <imsld:item identifier="Item-E3-LO1" identifierref="Item-E3-LO1"/>
    </imsld:learning-object>
    <imsld:learning-object identifier="LO-E3-LO2">
      <imsld:title>Instant Messaging</imsld:title>
      <imsld:item identifier="Item-E3-LO2" identifierref="Item-E3-LO2"/>
    </imsld:learning-object>
  </imsld:environment>

  <imsld:environment identifier="CollabTool">
    <imsld:title>CollaborationTools</imsld:title>
    <imsld:learning-object identifier="LO-E5-LO1">
      <imsld:title>Wiki</imsld:title>
      <imsld:item identifier="Item-E5-LO1" identifierref="Item-E5-LO1"/>
    </imsld:learning-object>
  </imsld:environment>

  <imsld:environment identifier="CM_Tools">
    <imsld:title>ConceptMapTools</imsld:title>
    <imsld:learning-object identifier="LO-E6-LO1">
      <imsld:title>Mind mapping software</imsld:title>
      <imsld:item identifier="Item-E6-LO1" identifierref="Item-E6-LO1"/>
    </imsld:learning-object>
  </imsld:environment>

  <imsld:environment identifier="ManagTools">
    <imsld:title>ProjectManagementTools</imsld:title>
    <imsld:learning-object identifier="LO-E7-LO1">
      <imsld:title>Project Manager</imsld:title>
      <imsld:item identifier="Item-E7-LO1" identifierref="Item-E7-LO1"/>
    </imsld:learning-object>
  </imsld:environment>
</imsld:environments>
<imsld:change-property-value>
  <imsld:property-ref ref="Missing_Project_Items"/>
  <imsld:property-value>"false"</imsld:property-value>
</imsld:change-property-value>
<imsld:show>
  <imsld:activity-structure-ref ref="P1-A1-AS3"/>
</imsld:show>
</imsld:then>

<imsld:if>
  <imsld:and>
    <imsld:is>
      <imsld:property-ref ref="CP-P1-A1-A5"/>
      <imsld:property-value>true</imsld:property-value>
    </imsld:is>
    <imsld:is-not>
      <imsld:property-ref ref="Missing_Project_Items"/>
      <imsld:property-value>true</imsld:property-value>
    </imsld:is-not>
  </imsld:and>
</imsld:if>
<imsld:then>
  <imsld:change-property-value>
    <imsld:property-ref ref="CP-P1-A1-A5"/>
    <imsld:property-value>false</ imsld:property-value>
  </imsld:change-property-value>
  <imsld:show>
  </imsld:show>
</imsld:then>

<imsld:if>
  <imsld:and>
    <imsld:is>
      <imsld:property-ref ref="CP-P1-A2-A1"/>
      <imsld:property-value>true</imsld:property-value>
    </imsld:is>
    <imsld:is>
      <imsld:property-ref ref="Solution_Not_Fit"/>
      <imsld:property-value>true</imsld:property-value>
    </imsld:is>
  </imsld:and>
</imsld:if>
<imsld:then>
  <imsld:change-property-value>
    <imsld:property-ref ref="CP-P1-A2-A1"/>
    <imsld:property-value>false</imsld:property-value>
  </imsld:change-property-value>
  <imsld:change-property-value>
    <imsld:property-ref ref="Solution_Not_Fit"/>
    <imsld:property-value>"false"</imsld:property-value>
  </imsld:change-property-value>
  <imsld:show>
    <imsld:activity-structure-ref ref="P1-A2-AS2"/>
  </imsld:show>
</imsld:then>

<imsld:if>
  <imsld:and>
    <imsld:is>
      <imsld:property-ref ref="CP-P1-A2-A1"/>
      <imsld:property-value>true</imsld:property-value>
    </imsld:is>
    <imsld:is>
      <imsld:property-ref ref="Agreement_Not_Achieved"/>
      <imsld:property-value>true</imsld:property-value>
    </imsld:is>
  </imsld:and>
</imsld:if>
<imsld:then>
  <imsld:change-property-value>
    <imsld:property-ref ref="CP-P1-A2-A1"/>
    <imsld:property-value>false</imsld:property-value>
  </imsld:change-property-value>
  <imsld:change-property-value>
    <imsld:property-ref ref="Agreement_Not_Achieved"/>
    <imsld:property-value>"false"</imsld:property-value>
  </imsld:change-property-value>
  <imsld:show>
    <imsld:activity-structure-ref ref="P1-A2-AS2"/>
  </imsld:show>
</imsld:then>
APPENDIX C: 360 degree Assessment XML Template

The XML code below presents the XML representation of the 360 degree assessment process analyzed in section C.6.2 of this document.

```xml
<?xml version="1.0" encoding="UTF-8"?><SimpleAssessment xmlns="http://TenCompetence.org" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://TenCompetence.org E:\CONTENT\[New]\_360DE~1\20060908_Before_Crete_Meeting\WP6\by_Mileni\XML\schema12\SimpleAssessment0_4.xsd">
  <AssessmentDesign>
    <AssessmentPlan stage="1.0">
      <name>360 degree assessment for persons teaching capability</name>
      <description>String</description>
      <todo>ToDo</todo>
      <Population>Individual</Population>
      <DecisionRule>
        <name>Name</name>
        <description>String</description>
        <todo>ToDo</todo>
        <Trait>
          <name>Name</name>
          <description>String</description>
          <todo>ToDo</todo>
        </Trait>
        <Trait>
          <name>Name</name>
          <description>String</description>
          <todo>ToDo</todo>
        </Trait>
        <Trait>
          <name>Name</name>
          <description>String</description>
          <todo>ToDo</todo>
        </Trait>
        <Trait>
          <name>Name</name>
          <description>String</description>
          <todo>ToDo</todo>
        </Trait>
        <TraitSimple>
          <name>Name</name>
          <description>String</description>
          <TraitStatus>passed</TraitStatus>
        </TraitSimple>
        <TraitSimple>
          <name>Name</name>
          <description>String</description>
          <TraitStatus>passed</TraitStatus>
        </TraitSimple>
        <TraitSimple>
          <name>Name</name>
          <description>String</description>
          <TraitStatus>passed</TraitStatus>
        </TraitSimple>
        <TraitSimple>
          <name>Name</name>
          <description>String</description>
          <TraitStatus>passed</TraitStatus>
        </TraitSimple>
        <TraitComplex>
          <name>Name</name>
          <description>String</description>
          <todo>ToDo</todo>
          <Trait>
            <name>Name</name>
            <description>String</description>
            <todo>ToDo</todo>
          </Trait>
          <Trait>
            <name>Name</name>
            <description>String</description>
            <todo>ToDo</todo>
          </Trait>
        </TraitComplex>
      </DecisionRule>
    </AssessmentPlan>
  </AssessmentDesign>
</SimpleAssessment>
```
<AssessmentPolicy><name>Name</name><description>String</description><todo>ToDo</todo></AssessmentPolicy>

<AssessmentScenario><name>Name</name><description>String</description><todo>ToDo</todo></AssessmentScenario>

<AssessmentScenario><name>Name</name><description>String</description><todo>ToDo</todo></AssessmentScenario>

<AssessmentScenario><name>Name</name><description>String</description><todo>ToDo</todo></AssessmentScenario>

<AssessmentSession><property>String</property><value>String</value><type>String</type><persistence>String</persistence><Population><role>Individual</role><name>String</name></Population></AssessmentSession>

<AssessmentSession><property>String</property><value>String</value><type>String</type><persistence>String</persistence><Population><role>Individual</role><name>String</name></Population></AssessmentSession>

<AssessmentSession><property>String</property><value>String</value><type>String</type><persistence>String</persistence><Population><role>Individual</role><name>String</name></Population></AssessmentSession>

<AssessmentPlan>
</AssessmentDesign>

<ItemConstruction stage="2.0">
<Item><name>Name</name><description>String</description><todo>ToDo</todo><Feedback>x</Feedback><Prompt>String</Prompt><Hint>String</Hint><CaseText>String</CaseText><ItemDetails>
<ConstructionItem><ItemID>String</ItemID><type>CONSTRUCTION</type></ConstructionItem>
</ItemDetails>
</Item>
</ItemConstruction>
<sinceDate>1967-08-13</sinceDate>
<RatingType>Individual</RatingType>
<ImpactFactor>0.5</ImpactFactor>
<ImpactPriority>0</ImpactPriority>
</rating>
<rating>
<AssessorReference>Text</AssessorReference>
<score>3.1415926535897932384626433832795</score>
<maxScores>3.1415926535897932384626433832795</maxScores>
<sinceDate>1967-08-13</sinceDate>
<RatingType>Individual</RatingType>
<ImpactFactor>0.5</ImpactFactor>
<ImpactPriority>0</ImpactPriority>
</rating>
</ResponseRating>
</TraitComplex>
<Rules>
<Rule>String</Rule>
<Rule>String</Rule>
<Rule>String</Rule>
</Rules>
<_PreRuleExpression>String</_PreRuleExpression>
<_PositionRuleExpression>String</_PositionRuleExpression>
<_PostRuleExpression>String</_PostRuleExpression>
</DecisionRule>
<AssessmentPolicy>
<name>Name</name>
<description>String</description>
<todo>ToDo</todo>
</AssessmentPolicy>
<AssessmentScenario>
<name>Name</name>
<description>String</description>
<todo>ToDo</todo>
</AssessmentScenario>
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<todo>ToDo</todo>
</AssessmentScenario>
<AssessmentScenario>
<name>Name</name>
<description>String</description>
<todo>ToDo</todo>
</AssessmentScenario>
<AssessmentSession>
<property>String</property>
<value>String</value>
<type>String</type>
<persistence>String</persistence>
</Population>
<role>Individual</role>
<name>String</name>
</Population>
</AssessmentSession>
<AssessmentSession>
    <property>String</property>
    <value>String</value>
    <type>String</type>
    <persistence>String</persistence>
    <Population>
        <role>Individual</role>
        <name>String</name>
    </Population>
</AssessmentSession>

<AssessmentSession>
    <property>String</property>
    <value>String</value>
    <type>String</type>
    <persistence>String</persistence>
    <Population>
        <role>Individual</role>
        <name>String</name>
    </Population>
</AssessmentSession>

</AssessmentPlan>

<AssessmentItems>
    <name>Name</name>
    <description>String</description>
    <todo>ToDo</todo>
    <Feedback>x</Feedback>
    <Prompt>String</Prompt>
    <Hint>String</Hint>
    <CaseText>String</CaseText>
    <ItemDetails>
        <ConstructionItem>
            <ItemID>String</ItemID>
            <type>CONSTRUCTION</type>
        </ConstructionItem>
    </ItemDetails>
    
    <ItemRawText CustomTypeName="ARCADE v.1.0">
        <Feedback>String</Feedback>
        <Hint>String</Hint>
        <CaseText>String</CaseText>
    </ItemRawText>
</AssessmentItems>

<AssessmentItems>
    <name>Name</name>
    <description>String</description>
    <todo>ToDo</todo>
    <Feedback>x</Feedback>
    <Prompt>String</Prompt>
    <Hint>String</Hint>
    <CaseText>String</CaseText>
    <ItemDetails>
        <ConstructionItem>
            <ItemID>String</ItemID>
            <type>CONSTRUCTION</type>
        </ConstructionItem>
    </ItemDetails>
    
    <ItemRawText CustomTypeName="ARCADE v.1.0">
        <Feedback>String</Feedback>
        <Hint>String</Hint>
        <CaseText>String</CaseText>
    </ItemRawText>
</AssessmentItems>

<AssessmentItems>
    <name>Name</name>
    <description>String</description>
    <todo>ToDo</todo>
    <Feedback>x</Feedback>
    <Prompt>String</Prompt>
    <Hint>String</Hint>
    <CaseText>String</CaseText>
    <ItemDetails>
        <ConstructionItem>
            <ItemID>String</ItemID>
            <type>CONSTRUCTION</type>
        </ConstructionItem>
    </ItemDetails>
    
    <ItemRawText CustomTypeName="ARCADE v.1.0">
        <Feedback>String</Feedback>
        <Hint>String</Hint>
        <CaseText>String</CaseText>
    </ItemRawText>
</AssessmentItems>
<Feedback>x</Feedback>
<Prompt>String</Prompt>
<Hint>String</Hint>
<CasestText>String</CasestText>
<ItemDetails>
  <ConstructionItem>
    <ItemID>String</ItemID>
    <type>CONSTRUCTION</type>
  </ConstructionItem>
</ItemDetails>
<ItemRawText CustomTypeName="ARCADE v.1.0">
  <Feedback>String</Feedback>
  <Hint>String</Hint>
  <CaseText>String</CaseText>
</ItemRawText>
</AssessmentItems>
</UnitOfAssessment>
</AssessmentConstruction>
<AssessmentRun stage="4.0">
  <name>String</name>
  <description>String</description>
  <todo>ToDo</todo>
</AssessmentRun>
<ResponseProcessing>
  <name>String</name>
  <description>String</description>
  <todo>ToDo</todo>
</ResponseProcessing>
<DecisionMaking stage="6.0">
  <name>String</name>
  <description>String</description>
  <todo>ToDo</todo>
</DecisionMaking>
</SimpleAssessment>
The XML code below presents the IMS LD representation of the “Astronomy” scenario analyzed in section D.8.1 of this document.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<manifest xmlns="http://www.imsglobal.org/xsd/imscp_v1p1"
    xmlns:imsld="http://www.imsglobal.org/xsd/imsld_v1p0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.imsglobal.org/xsd/imscp_v1p1
http://www.imsglobal.org/xsd/imscp_v1p1.xsd
http://www.imsglobal.org/xsd/imsld_v1p0 IMS_LD_Level_B.xsd" identifier="ast-
manifest">
<organizations>
<imsld:learning-design identifier="Astronomy" level="B" sequence-used="false"
    uri="Ast">
    <imsld:title>Learning about astromony</imsld:title>
    <imsld:learning-objectives>
        <imsld:title>Here are the objectives</imsld:title>
        <imsld:item identifierref="R-LO" identifier="I-LO" isvisible="true"/>
    </imsld:learning-objectives>
    <imsld:prerequisites>
        <imsld:title>Here are the prerequisites</imsld:title>
        <imsld:item identifierref="R-PRE" identifier="I-PRE" isvisible="true"/>
    </imsld:prerequisites>
</imsld:learning-design>
</organizations>
<imsld:components>
<imsld:roles>
<imsld:learner identifier="R-Learner">
    <imsld:title>All learners</imsld:title>
</imsld:learner>
<imsld:learner identifier="R-Team-A">
    <imsld:title>Team A</imsld:title>
</imsld:learner>
<imsld:learner identifier="R-Team-B">
    <imsld:title>Team B</imsld:title>
</imsld:learner>
<imsld:staff identifier="Tutor">
    <imsld:title>Teacher</imsld:title>
</imsld:staff>
</imsld:roles>
<imsld:properties>
<imsld:locrole-property identifier="InterviewA">
    <imsld:role-ref ref="R-Team-A"/>
    <imsld:datatype datatype="file"/>
</imsld:locrole-property>
<imsld:locrole-property identifier="InterviewB">
    <imsld:role-ref ref="R-Team-B"/>
    <imsld:datatype datatype="file"/>
</imsld:locrole-property>
<imsld:locpers-property identifier="LP-Planet-Order">
    <imsld:title>Learner answer</imsld:title>
    <imsld:datatype datatype="text"/>
    <imsld:init-value>1- -2- -3- -4- -5- -6- -7- -8- -9- </imsld:init-value>
</imsld:locpers-property>
</imsld:properties>
<imsld:activities>
<imsld:learning-activity
```
WP6 Milestone M6.1

identifier="LA-cooperate-to-name-and-order-planets" isvisible="true">
  <imsld:title>Cooperate on the planets</imsld:title>
  <imsld:activity-description>
    <imsld:item identifierref="I-cooperate-to-name-and-order-planets" isvisible="true">
      ***cooperate on the planets***
    </imsld:item>
  </imsld:activity-description>
</imsld:learning-activity>
</imsld:title>
</imsld:activity-description>
</imsld:learning-activity>
</imsld:support-activity>
</imsld:title>
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</imsld:activity-description>
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</imsld:title>
</imsld:activity-description>
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</imsld:support-activity>
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</imsld:activity-description>
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</imsld:title>
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</imsld:activity-description>
</imsld:learning-activity>
</imsld:support-activity>
</imsld:title>
</imsld:activity-description>
</imsld:learning-activity>
</imsld:support-activity>
<imsld:activity-structure identifier="SS1">
<imsld:title>Teacher's environment</imsld:title>
<imsld:environment ref="ENV-Shared"/>
<imsld:environment ref="ENV-Team-A"/>
<imsld:environment ref="ENV-Team-B"/>
<imsld:support-activity-ref ref="SA-first-step"/>
</imsld:activity-structure>
</imsld:activities>
<imsld:environments>
<imsld:environment identifier="ENV-Shared">
<imsld:title>Forum for exchanging information on the planets</imsld:title>
<imsld:service identifier="SERV_act1_forum" isvisible="true">
<imsld:conference conference-type="asynchronous">
<imsld:title>Forum shared between team A and B</imsld:title>
<imsld:participant role-ref="R-Learner"/>
<imsld:observer role-ref="Tutor"/>
<imsld:item identifier="I-Forum" identifierref="R-Forum" isvisible="true"/>
</imsld:conference>
</imsld:service>
</imsld:environment>
<imsld:environment identifier="ENV-Team-A">
<imsld:title>Expert Interview and chat for Team A</imsld:title>
<imsld:learning-object identifier="LO-TeamA" isvisible="true" type="knowledge-object">
<imsld:title>Link to the interview text for team A</imsld:title>
<imsld:item identifier="I-Interview-A" identifierref="R-Interview-A" isvisible="true"/>
</imsld:learning-object>
<imsld:service identifier="S-Chat-A" isvisible="true">
<imsld:conference conference-type="synchronous">
<imsld:title>Chat for team A only</imsld:title>
<imsld:participant role-ref="R-Team-A"/>
<imsld:participant role-ref="Tutor"/>
<imsld:item identifier="I-Chat-A" identifierref="R-Chat-A" isvisible="true"/>
</imsld:conference>
</imsld:service>
</imsld:environment>
<imsld:environment identifier="ENV-Team-B">
<imsld:title>Expert Interview and chat for Team B</imsld:title>
<imsld:learning-object identifier="LO-TeamB" isvisible="true">
<imsld:title>Link to the interview text for team B</imsld:title>
<imsld:item identifier="I-Interview-B" identifierref="R-Interview-B" isvisible="true"/>
</imsld:learning-object>
<imsld:service identifier="S-Chat-B" isvisible="true">
<imsld:conference conference-type="synchronous">
<imsld:title>Chat for team B only</imsld:title>
<imsld:participant role-ref="R-Team-B"/>
<imsld:participant role-ref="Tutor"/>
<imsld:item identifier="I-Chat-B" identifierref="R-Chat-B" isvisible="true"/>
</imsld:conference>
</imsld:service>
</imsld:environment>
<imsld:environment identifier="ENV-Monitor-Answers">
<imsld:title>Check how the Learners are doing</imsld:title>
<imsld:service identifier="S-monitor-answers">
<imsld:monitor>
<imsld:role-ref ref="R-Learner"/>
</imsld:monitor>
</imsld:service>
</imsld:environment>
</imsld:environments>
Answers to the questions

A unit of learning on astromony

Learning together about astromomy

Team A's Part in the Process

Team B's part in the process

The Teacher's part

The Teacher's part

Answering the questions

TenCompetence – IST-2005-027087
<imsld:activity-structure-ref ref="AS2"/>
</imsld:hide>
<imsld:hide>
  <imsld:activity-structure-ref ref="SS1"/>
</imsld:hide>

</imsld:then>
</imsld:conditions>
</imsld:method>
</imsld:learning-design>
</organizations>

<resources>
  <resource identifier="R-LO" type="webcontent" href="learning-objectives.xml">
    <file href="learning-objectives.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-PRE" type="webcontent" href="prerequisites.xml">
    <file href="prerequisites.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-Forum" type="webcontent" href="forum.xml">
    <file href="forum.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-Chat-A" type="webcontent" href="chatA.xml">
    <file href="chatA.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-Chat-B" type="webcontent" href="chatB.xml">
    <file href="chatB.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-Interview-A" type="imsldcontent" href="interviewA.xml">
    <file href="interviewA.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-Interview-B" type="imsldcontent" href="interviewB.xml">
    <file href="interviewB.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-cooperate-to-name-and-order-planets" type="imsldcontent" href="cooperate.xml">
    <file href="cooperate.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-sa-round-off-first-act" type="imsldcontent" href="monitor.xml">
    <file href="monitor.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-Complete-Q" type="imsldcontent" href="questions.xml">
    <file href="questions.xml"/>
    <file href="icalt.css"/>
  </resource>
  <resource identifier="R-sa-monitor-answers" type="imsldcontent" href="monitoranswers.xml">
    <file href="monitoranswers.xml"/>
    <file href="icalt.css"/>
  </resource>
</resources>
</manifest>
The XML code below presents the IMS LD representation of the “Guitar Playing for Beginners” scenario analyzed in section D.8.2 of this document.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<manifest xmlns="http://www.imsglobal.org/xsd/imscp_v1p1"
xmlns:imsld="http://www.imsglobal.org/xsd/imsld_v1p0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.imsglobal.org/xsd/imscp_v1p1
http://www.imsglobal.org/xsd/imscp_v1p1.xsd
http://www.imsglobal.org/xsd/imsld_v1p0
http://www.imsglobal.org/xsd/IMS_LD_Level_B.xsd" identifier="manifest-A6444FB2-A5AD-058A-C8CF-F295AA595C02">
<organizations>
<imsld:learning-design
identifier="ld-72b8cef4-aa20-d6ce-0742-9c0f9b655105" level="B"
sequence-used="false"
uri="http://www.reload.ac.uk/uri/ld-72b8cef4-aa20-d6ce-0742-9c0f9b655105">
<imsld:title>Guitar Playing for Beginners</imsld:title>
</imsld:learning-design>
<imsld:components>
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