## D66 – Evaluation Results

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<thead>
<tr>
<th>Workpackage</th>
<th>WP6. Pilots Validation</th>
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<td>T63/T65. Pilot Site Validation</td>
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<tr>
<td>Contributors</td>
<td>KLETT, EDP, OUNL, UNED; SAGE; ACE CASE</td>
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| Abstract (for dissemination) | This deliverable compiles and analyses the results of the whole evaluation of the ALFANET system developed during the ALFANET Project (IST 2001-33288). It provides the basis for further development of ALFANET components, offering summary conclusions from the experiences gathered at the different stages of the e-Learning life-cycle. |
| Keywords List    | Evaluation Results, Validation, Assessment, Verification, Usability |
Executive Summary

Introduction

The D66. Evaluation Results compiles and analyses the results of the whole evaluation of the ALFANET system developed during the ALFANET Project (IST 2001-33288). It provides the basis for further development of ALFANET components, offering summary conclusions from the experiences gathered at the different stages of the e-Learning life-cycle.

ALFANET has delivered an e-Learning system providing adaptive e-Learning capabilities to Learners. The platform supports adaptation through the e-Learning life-cycle and is made of four main subsystems: Authoring (Design phase), Administration, LMS e-Learning Instruction subsystem (Use), and Auditing subsystem.

For the Design phase, ALFANET provides authoring tools that allow to design the course, making use of key e-Learning standards, namely:

- The LD Authoring Tool allows the course authors to generate e-learning courses based on IMS LD, including metadata IMS MD / IEEE LOM and generated the whole package as IMS CP.
- The QTI Authoring Tool supports the introduction of Metadata in the IMS QTI items and the generation of dynamic and adaptive questionnaires based on the Selection & Ordering specification provided by IMS QTI. It receives as input QTI items packaged with IMS CP.

For the phases of Administration, Use and Audit, ALFANET provides an integrated platform designed as a services based architecture that provides the platform with flexibility, modularity and extensibility capabilities.

Description of conclusions/results

The evaluation for the first prototype was focused on the Design phase. The second prototype covers the whole life-cycle and for the final system the evaluation is concentrated on the LMS use phase.

Four adaptive pilot courses have been designed in the project, corresponding with the four pilot sites: “Spanish course for German Learners” (KLETT), “Environment and Electrical Distribution” (EDP), “How to teach through the Internet ” (UNED) and “Communication technology” (OUNL). These courses implement different adaptive features and will be used for dissemination activities by the Consortium partners. An other course has been produced with the purpose of adaptation testing and internal dissemination activities.

Regarding the phases evaluated by the pilot sites,

- KLETT and EDP review the whole process life cycle, but main focus is on authoring tools and LMS use, leaving out the Publication and Administration phase and the Feedback to the author with the audit.
- UNED performs an evaluation of the functionality on the design, publication and use phases; and not focused on usability as the rest of the pilot sites.
- OUNL focuses on usability assessment of the LMS, and especially the audit module.

On the design phase further work have to be done about:

- Improvement and integration of the authoring tools.
- the user manual, explaining how to implement different adaptive scenarios instead of focusing on the typical use of menus. This activity has been already started with the adaptive scenarios described in D65, and the result is positively evaluated by users.

The outcomes from evaluation activities at Use phase are:

- The effectiveness of the LMS is rated positive. It is possible to reach the learning objectives – depending on the quality of the course contents - with the Alfanet system.
- The efficiency is rated less positive. The participants suffered performance problems.
- The usability and navigation using the current interfaces is seen as a weak point. Nevertheless it is noted that the personalization and the possibility of defining different presentation templates may help to fix this problem. Experiences with the course menus template are rated as more positive.

Although the adaptivity of the system regarding recommendations is not sufficiently evaluated, important feedback and suggestions for improvement has been collected.
The improvements implemented in the last months are also rated as very positive by the users partners.
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1. Introduction

ALFANET aims to develop new methods and services for active and adaptive learning. The project’s target is to deliver a tested set of components for eLearning providers (mainly educational centres providing accredited courses) interoperable with their platforms and/or services, that will significantly provide enhanced individual learning, through technologies with adaptive features and approaches concerned with personalisation and adaptation.

1.1 Project Objectives

ALFANET concentrates itself on the recently emerging market of eLearning, an area that will undoubtedly take advantage of the new technologies related with the Internet, human interaction, and machine learning. More specifically:

- ALFANET will allow individuals to have an interactive, adaptive and personalised learning through the internet bringing them the opportunity to learn on those matters that are relevant to perform and to improve their work.

- ALFANET will allow service providers or educational centres to provide eLearning services adapted to the individuals background, experience and behaviour.

- ALFANET will allow learning content providers to produce learning contents in a way that can be adapted to the personal needs of the individual learner.

During the first review meeting, the project objectives were reassessed and a refocus was made. The project focuses on individual adaptive learning and generation of knowledge and tools for service providers. This approach allows the Consortium to investigate on new key aspects contributing to the eLearning arena.

So, the concrete objectives and expected results of the project are:

1. To develop a prototype of a Learning Management System (LMS). The focus in the development will be on a set of components that offer intelligent personalisation capabilities, addressing the problem of the effective adaptive learning.

2. At the time, the LMS will prove the concept of combining machine learning and multi-agent technology for intelligent interactive eLearning.

3. A proposal for contributing to the current standards of the eLearning field in the adaptation and personalisation on contents and pedagogical learning methods.

4. An evaluation of the prototype’s impact on the current individual learning needs, which will be measured at different scenarios.

5. A description of the project results in terms of internal usage by the Consortium and a set of components for potential exploitation by third parties (eLearning service providers)

The project will have a significant contribution to knowledge in the area of adaptive eLearning, eLearning standards usage, and the potential exploitation of some of the components by eLearning service providers.

1.2 Situation

This report compiles the evaluation activities performed by the consortium partners during the ALFANET Project (IST 2001-33288).

Evaluation activities starts from the beginning of the project with task T14. Assessment and Validation Plan that defines an initial evaluation plan and provides the criteria and procedures to evaluate the fulfilment of application requirements and the functionality described in the Specifications. This evaluation plan addresses important issues as usability and effectiveness of e-learning. Two users pilot sites are initially defined. D14 has been delivered to the EC by March 4th, 2003.

The Evaluation plan (D14) is refined in further project stages, delivering D61_v1 and D61_v2. The first one offers some adjustments to the new project focus, incorporating the two new pilot sites (UNED and OUNL) and attending the recommendations performed by the reviewers in the First Review. Additionally, the plan provides more detail on the different actors that play in the Evaluation stage: learners, tutors, author and
managers, more clear definition of adaptive features and evaluation indicators. The D61. Evaluation Plan report was delivered to the EC by February 2, 2004.

A revised version of the Evaluation plan (D61_v2) is produced having into account the comments received at the review meetings: focus on adaptation, eliminate the evaluation of adaptive features addressed to the tutor; and focus the validation on functionality and usability and discounting effectiveness, which can not, in the opinion of the reviewers, be properly validated at this stage. The D61. Evaluation Plan report version 2 was delivered to the EC by December 14, 2004.

In T62 and T64 Pilot Sites – Definition, partners prepared the pilots environment, selecting the content material subject of the tests, preparing the content to be supported by the LMS through the use of ALFANET Authoring tools, identifying adaptation opportunities and continuously refining the course.

T63 and T65 Pilot Sites – Validation includes the trials of the three incremental prototypes to obtain feedback to developers. The evaluation activities were performed along all the project as soon as the first prototype was available.

The results of these activities are collected into different reports.

D62- Assessment of Pilot Sites (first prototype) was delivered to the EC on July 29, 2004, including the evaluation activities performed in EDP and KLETT pilot sites. It was based on the D61_v1 Evaluation Plan.

D63- Assessment of Pilot Sites (second prototype) and D64 Assessment of Final System were delivered to the EC on April 14, 2004. The evaluation activities were carried out in the four pilot sites, and they are based on ALFANET_D61_V2 Evaluation Plan.

1.3 Purpose

The D66. Evaluation Results compiles and analyses the results of the whole evaluation of the ALFANET system developed during the ALFANET Project (IST 2001-33288). It provides the basis for further development of ALFANET components, offering summary conclusions from the experiences gathered at the different stages of the eLearning life-cycle.

This report is addressed to the general public.

1.4 Overview

Chapter 2. Evaluation Along The Project outlines the iterative cycle of pilot sites definition and validation together with the production of successive prototypes (development)

Chapter 3. Pilot Sites briefly describes the four pilot sites generated in the project and the main adaptive features that they implement.

Chapter 4. Evaluation Experiences Along The E-Learning Life-Cycle compiles the main results of the evaluation related to the different components, obtained from the experiences gathered at the different stages of the eLearning life-cycle.

Chapter 5. Adaptation Assessment Results outlines the evaluation related with the adaptive features.

Chapter 6. Conclusions provides the evaluation conclusions.

The references to other documents are included in Appendix 1. References
2. Evaluation along the project

WP6. Pilots Validation. started in October 2002 and takes care of assessing the correct functioning of the final application, both from the functional and operational point of view, and also from the usability perspective that have conducted the different stages of the project life-cycle.

Following we outline the iterative cycle of pilot sites definition and validation together with the production of successive prototypes (development):

- Users started the definition of the Pilot Sites by defining adaptive needs for their pilot sites that were compiled into an Adaptation Catalogue [ALFANET-Adaptation-Catalogue], further analysed by development partners.

  In parallel, the work was focused on the definition of the Evaluation Plan [ALFANET_D61]

- After a period on integration, the First system prototype was produced in January, 2004. The focus of this prototype was to provide two main subsystems: a first version of the Authoring tool to support the design of LD based courses; and an integrated LMS providing services to the Learner as course navigation and collaboration services. Core components belonging to the architecture were developed in this phase. The functionality of the first prototype is described at [ALFANET_D41] report.

- Validation of First Prototype (D62). Testing of the Authoring tool started first. Then the first prototype of the LMS was initially tested with a sample course created. Once the Pilot courses were created, a more wider evaluation of the first prototype was performed. The results, which are compiled at [ALFANET_D62], feed development activities that resulted in some improvements for the Second prototype.

- A second stage of Pilot Sites preparation was performed on the basis of a methodology to integrate a double view of adaptiveness: conceptual and technical. As a consequence a Concept Learning template [ALFANET-Concept-template] was created by pedagogical experts and validated both by users (usage of the template in the definition of courses) and by developers that further completed with technical requirements for adaptation.

- After a period on integration, the Second system prototype was delivered in August 13, 2004 (first version of integrated software). In September several updates (improvements) of the prototype have been provided, and the formal report corresponding with the second prototype has been delivered in September 23. The functionality of the second prototype is described at D42 report.

- The Validation of the Second prototype (D63) extended from October 2004 to February 2005. The reasons for such extensive period is more related with the scope of the pilot courses: the Consortium joins Validation of the Second Prototype with the existence of a first version of adaptive courses; and refers to the Validation of the Final System when the final adaptive course is available.

- Validation of the Second prototype is focused on two lines: (a) Validation of the Authoring phase thus concluding the Final version of the pilot adaptive courses; and (b) Validation of the LMS with the adaptive features defined in the first course.

- The Final System prototype was delivered in February 15, 2005 (a previous beta version was produced by December 24). In this period, several updates (improvements) of the prototype have been provided, and the formal report corresponding with the Final prototype [ALFANET_D43] has been delivered in March 22, 2005.

- The third stage Pilot Sites preparation was then performed along Validation activities of the Second prototype, and counted with the support of development partners. This concluded with the definition of the final version of adaptive courses.

- The Validation of the Final system (D64) was performed between mid February and mid April 2005. The evaluation focused on the validation of the LMS adaptive features as well as on the validation of administrative and auditing functions supporting the e-Learning life cycle.

- Supporting User Manuals were delivered by development partners each time a prototype was delivered for validation. The final version of the User Manuals has been compiled and completed by users with the support of the development partners. This has resulted in the core User Manual [ALFANET_D65] that counts with a set of manuals addressed to Authors, Administrators, Learners and Tutors.
3. Pilot sites

Four adaptive pilot courses have been designed in the project, corresponding with the four pilot sites: “Spanish course for German Learners” (KLETT), “Environment and Electrical Distribution” (EDP), “How to teach through the Internet” (UNED) and “Communication technology” (OUNL). These courses implement different adaptive features and will be used for dissemination activities by the Consortium partners. Other course has been produced with the purpose of adaptation testing and internal dissemination activities.

This section briefly describes the four pilot sites generated in the project and the main adaptive features that they implement.

3.1.1 Spanish course for German speaking people

KLETT language course ‘Spanish for Beginners’ consists of four lessons of progressive difficulty. ‘Each lesson contains concept learning materials of four modules: Listening and reading comprehension (RC), Grammar (G), Communication abilities (CA), and Intercultural competencies (IC). For RC, G, and CA modules assessments are provided.

The course is offered in two versions: for inductive visual learners as well as for deductive verbal learners. Both learning style and cognitive modality of the individual learner are defined by two questionnaires the learner fills in before starting with the course. According to this evaluation of the user’s learning style and cognitive modality the system presents the respective version of the course.

Each lesson contains concept learning materials, collaborative tasks and assessments (optional self assessment, mandatory lesson assessment, and – if lesson assessment failed – remediation assessment). The learner can choose freely in what order to study concept learning materials and do collaborative tasks within a lesson. But before s/he is allowed to proceed to the next lesson s/he needs to pass the lesson assessment or – if necessary – the remediation assessment. Assessments are highly adaptive:

- First of all the learner – prior to starting with the first lesson - is offered a pre-knowledge assessment: If s/he has some prior knowledge of Spanish language the learner is advised do the pre-knowledge assessment and according to his/her scoring might be allowed to immediately start with lesson 2 or a higher lesson.

- The learner has the opportunity and sometimes (after having finished activities related with a certain module) receives the recommendation to do self assessment. If s/he performed well and the self assessment is passed, the respective questionnaire(s) will no more be included in the lesson assessment.

- If a learner has difficulties with a certain assessment (either in the self-assessment phase or in the lesson assessment phase) s/he is recommended to do remediation activities to overcome his/her weaknesses. If problems had been coming up in the lesson assessment phase the respective questionnaires have to be repeated (remediation assessment).

- Thus the learner might get the same kind of assessment twice, but the selection & ordering functionality takes care that the content of the single questionnaire randomly varies.

KLETT review the whole process life cycle, but main focus is on authoring tools and LMS use, leaving out the Publication and Administration phase and the Feedback to the author with the audit.

3.1.2 Environment and Electrical Distribution

EDP pilot site is focused on the corporate training in the environmental area, specifically in what implies environmental sensibleness in Electrical Distribution, addressing people in a professional context.

The test course presents a modular structure, being each module constituted by lessons or units of learning, some of them without precedence. Mandatory and optional exercises are available to learners within each lesson. Every module has an evaluation whose results are complemented by those coming from a global assessment, done at the end of the course.

Next figure offers the structure of Module 2 composed by 5 lessons.
The course makes use of LD design but adaptation is not mainly implemented in LD but facilitated by the Adaptation module based on metadata. The learning design is developed according to the existence of:

- Different levels of knowledge and/or interest within each learning unit
- Connections between learning units allowing several sequences

EDP review the whole process life cycle, but main focus is on authoring tools and LMS use, leaving out the Publication and Administration phase and the Feedback to the author with the audit.

### 3.1.3 How to teach through the Internet

The UNED pilot defined a course about “How to teach through the Internet” taking as starting point some didactic material belonging to the existing course (in a program of teachers’ training) active during 4-5 years. The course: “Aprender a Formar en Internet “ is composed of four modules, the first one includes ten activities for introducing the learner with the ALFANET services and collect initial data with the profile questionnaires; the next two modules follow the concept learning templates guidelines; the fourth module configures collaborative activities using the Collaborative Framework. The course finalises with a Final Assessment.

Next image shows the course structure as viewed by the learners.
The duration of the course is estimated on 20 hours.

The course includes diversity in learning material (for inductive / deductive; for beginner / advanced); learning objects characterised with IMS-MD / LOM metadata, adaptation rules defined at design and static adaptation rules defined within the Configuration of Recommendations module. Also several banks of items are defined for self-assessment, questionnaires and final exam, experiencing the use of QTI standard. The learning objectives has an important role for the evaluation of this pilot site. Learning activities, Learning objects and QTI Items have associated Learning Objectives.

UNED performs an evaluation of the functionality on the design, publication and use phases; and not focused on usability as the rest of the pilot sites. The evaluation of the design phase is analysed both from the conceptual and the technological point of view. Publication and Administration phase is also reviewed (with more emphasis than in the other pilot sites). The LMS use phase is assessed with the focus of detect improvements on the functionality provided by the Interactive Services as well as to obtain the impact of learners with the recommendations provided by the Adaptation Module.
3.1.4 Communication technology, Architecture and applications

The Commtech course of the OUNL consists of three modules that follow the didactical model of the Multiagent Pedagogical Model subproject and the resulting template closely.

The three modules in the Alfanet electronic course contain adapted parts of the existing OUNL course "Communication technology", which consists of four main parts and is published as written text in a course book:

- **Introduction**: five chapters in which the field communication technology and the topics in the rest of the course are introduced, based on case studies.
- **Fundamentals**: six chapters about the fundamentals of communication technology, like signal theory, information theory, modulation and multiplex techniques.
- **Architecture**: four chapters about architectural aspects like the OSI (seven)-layer model, topologies and dynamical aspects of communication networks
- **Applications**: three chapters about applications of the theory learned. Topics which are treated are: fixed networks, local networks and mobile networks.

We discuss the structure of the electronic course used in the Alfanet validation. The activity-structure is shown (in Dutch) in the next figure.

The course consists of three modules:

1. an introduction on Internet and www,
2. principles of decomposition and protocols, and
3. continues signals.
Before a student starts with the course he or she fills in an assessment. Based on this assessment the variables of the Multiagent Pedagogical Model are filled in: learning style, cognitive modality and level of knowledge (in the module on continues signals). Based on these variables adaptivity is offered:

- Activities are (sequentially) offered based on student's profile, completed activities and questionnaire results. This profile determines the on line the study path.
- Recommendations about functionality are given.

The first module (an introduction on the internet and the www) consists of a study text and is finished by an assessment of multiple-choice questions. In this module there is no interactivity. If a student does not pass the assessment, he or she is advised to study this module again.

The second module (principles of decomposition and protocols) consists of two parts: firstly a study text about the topics decomposition and protocols, and secondly a web-based tool by which students are able to investigate an internet protocol. Again, this module is finished by an assessment of multiple-choice questions. If a student does not pass the assessment, he or she is advised to study this module again.

The third module treats signal theory. The module structure is as follows. First a unit about “oscillations and sinusoidal waves” is presented. Based on the first assessment outcome (student's learning style) the content is presented in an inductive (first examples followed by definitions) or in a deductive way (first definitions followed by examples). This part is finished by an assessment of multiple-choice questions. If a student does not pass the assessment, remedial teaching is offered. Again based on the first assessments outcome (student's cognitive modality) the learning material is delivered verbal (text and symbols) or visual (animations, which are supported by explanations).

Beside this advised learning path (activity structure), which is based on a pre assessment, students are able to select learning objects and activities. For that purpose all learning objects and activities are collected and presented in a list.

The course is implemented using three standards: IMS-LD, IEEE-LOM and IMS-QTI.

OUNL evaluation focuses on usability assessment of the LMS, and especially the audit module.

### 3.1.5 Adaptive scope of the pilot sites

Next table summarises the scope of each one pilot site in that refers to adaptive features included in the courses. More detailed information about each one of the adaptive features is explained at [ALFANET_D65].

For understanding the meaning of this table: X means the pilot site uses the adaptive feature; XX - means the pilot site extensively uses the adaptive feature and XXX - the adaptive feature is the main focus of this pilot site.
3.1.6 Participation in Experiences of the Pilot Sites

For the first prototype the evaluation of the Authoring Tool took place in different stages at different times:

- The first tests were done in November 2003 by an IMS LD expert at OUNL with one of the first releases of the tool.
- In February 2004 Consortium Members attained a training in IMS LD and the usage of the Authoring Tool and they also evaluated the tool.
- In May and June 2004 authors at both pilot sites – KLETT and EDP – created courses with the Authoring Tool and evaluated its usability.

Table 1. Adaptive Features and the scope for pilot sites

<table>
<thead>
<tr>
<th>ALFANET Feature (category)</th>
<th>Adaptive Feature</th>
<th>KLETT</th>
<th>EDP</th>
<th>UNED</th>
<th>OUNL</th>
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<tr>
<td>Dynamic Adaptive questionnaires</td>
<td>• Self assessment (with/without influencing other dynamic assessments)</td>
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<td>XX</td>
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<td>XX</td>
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<tr>
<td></td>
<td>• Lesson assessment</td>
<td>XX</td>
<td></td>
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<td>XX</td>
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<tr>
<td></td>
<td>• Final assessment</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
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<td></td>
<td>• Remediation assessment</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>Presentation</td>
<td>• Personalised Presentation</td>
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<td>XX</td>
<td>X</td>
<td>XX</td>
</tr>
<tr>
<td></td>
<td>• Adaptive Presentation</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td>XX</td>
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<tr>
<td>Recommendion during interaction</td>
<td>• User Modelling: activity level in objectives/ in course</td>
<td>X</td>
<td>X</td>
<td>XXX</td>
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<tr>
<td>Run-time Adaptation (Adaptation Module)</td>
<td>• Diagnosis of lack of knowledge in objectives / in course content</td>
<td>X</td>
<td>X</td>
<td>XXX</td>
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<tr>
<td></td>
<td>• Diagnosis of the interest level in objectives/ in course content</td>
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<tr>
<td></td>
<td>• Recommend Learning Material (for remediation or additional information)</td>
<td>XX</td>
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<td>• Recommend self-assessment</td>
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<td></td>
<td>• Recommend other LD items</td>
<td>X</td>
<td>X</td>
<td>XXX</td>
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<tr>
<td></td>
<td>• Create and present motivational messages</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td></td>
<td>• Recommend peer interactions (support peer-to-peer collaboration)</td>
<td>XX</td>
<td></td>
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<tr>
<td>Learning Route from Design</td>
<td>• Pedagogical Model: Concept Learning Template</td>
<td>XX</td>
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<td></td>
<td>• Pre-designed adaptations rules</td>
<td>XX</td>
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<tr>
<td>Collaboration</td>
<td>• Individual self-learning</td>
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<td></td>
<td>• Implicit collaboration</td>
<td>XX</td>
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<td></td>
<td>• Tutor-Learner interactions</td>
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<tr>
<td></td>
<td>• Learner-learner interactions (peer-to-peer)</td>
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</tr>
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<td></td>
<td>• Group work</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Feedback to the author</td>
<td>• Create and present reports</td>
<td>XX</td>
<td>X</td>
<td></td>
<td>XXX</td>
</tr>
</tbody>
</table>

Table 1. Adaptive Features and the scope for pilot sites
For the verification assessment of the Authoring Tool tests were executed to check functionalities provided by the Tool against the functionalities stated by the IMS LD Information Model and to compare the resulting IMS LD Code with the IMS LD Specifications.

The assessment of the Learning Management System was done by the authors of the course. When the courses are published they had to check whether the functionality is correct or not. They also should assess that the course - as it is presented to learners and tutors - is in accordance with the expectations of the authors. Authors were also asked to give recommendations for improvements.

Similar to the usability assessment of the Authoring Tool the evaluation of the Learning Management System was executed at different times and places. The first evaluation (using a sample course) was done in February 2004 and was discussed during a Consortium Meeting in Lisbon. Some improvements were made and in May 2004 EDP assessed the LMS with the same sample course. After KLETT and EDP had created their pilot courses they both evaluated their respective courses in June 2004.

The usability assessment was split into a Diagnostic Evaluation to identify usability problems and a Subjective Evaluation to ask for the users feeling when working with the software. Qualitative data are gathered by means of a survey as well as by means of a questionnaire.

A total of 22 people participate in the two trials of the first prototype.

For the second prototype the four pilot sites are involved, with a total of 31 participants. The evaluation took place from October 2004 to February 2005.

- KLETT and EDP review the whole process life cycle, but main focus is on authoring tools and LMS use, leaving out the Publication and Administration phase and the Feedback to the author with the audit.

- UNED performs an evaluation of the functionality on the design, publication and use phases; and not focused on usability as the rest of the pilot sites. The evaluation of the design phase is analysed both from the conceptual and the technological point of view. Publication and Administration phase is also reviewed (with more emphasis than in the other pilot sites). The LMS use phase is assessed with the focus of detect improvements on the functionality provided by the Interactive Services as well as to obtain the first impact of learners with the recommendations provided by the Adaptation Module.

- OUNL focuses on usability assessment of the LMS, and especially the audit module. Three staff members of the faculty of Informatics at the OUNL were involved in the ALFANET usability validation, which consists of three parts: 1) the Alfanet learning environment, 2) a small course about communication technology, and 3) the audit module. Two methods for data collection were used: 1) individual expert walkthrough, and 2) focus group discussion.

Along User Evaluation activities malfunctions, errors, and additional requirements detected during the tests were reported immediately to development partners and corrected as soon as possible.

The evaluation of the Final System took place between February and April 05 at the four pilot sites with different learners not involved in the ALFANET project. A total of 52 learners participate in the set of four trials. The focus of the evaluation activities vary along the different pilot sites:

- KLETT focuses the validation of the Use and Audit phases. For the Use phase, the focus was on LD adaptive paths and Adaptive Assessments.

- EDP focuses the validation on the Use phase. The course definition offers diversity in learning objects characterised with metadata and the opportunity to test collaborative activities. The freedom for the learner is an important issue to take into account; also a reasonable bank of items is included for self-assessment during the course.

- The evaluation in UNED is focused on the Use phase, more specifically on the recommendations during the interaction. The validation of the final system suffered several delays mainly due to external circumstances. A total of 25 learners and 2 tutors are testing the ALFANET system with the AprFormInternet course. The course includes diversity in learning material (for inductive / deductive; for beginner / advanced); learning objects characterised with LOM metadata, adaptation rules defined at design and static adaptation rules defined within the Configuration of Recommendations module. Also several banks of items are defined for self-assessment, questionnaires and final exam, experiencing the use of QTI standard. By now, no relevant results can be described.

- OUNL focused the validation of the Use and Audit phases. In the 3rd week of March for the final evaluation in total 11 OUNL students studied the Comtech course. The half of these students have no experience with e-learning, the 6 other have (some) experience. The students could study the course in the Alfanet system during 5 days. They got a manual about how to use the Alfanet system with special
emphasis to the adaptive features. At the end of the evaluation the students gave their comments on the Alfanet system, mainly by filling the usability assessment questionnaire.

SAGE also provides the validation results of the adaptive flows when testing interoperability of standards. After having performed the technical verification, SAGE validated the adaptive flow, by checking how ALFANET system provided different e-Learning paths (according to what was defined in IMS-LD and IMS-QTI) for different learners profiles and their evolution in the course. This validation was performed with an specific course designed for these purposes, and with the final version of KLETT course. Moreover, the functionality of Alfanet was evaluated by a technical group with experience in e-learning platforms.

Next table summarise the number of people involved in the user pilot experiences.

<table>
<thead>
<tr>
<th>Prototype</th>
<th>KLETT</th>
<th>EDP</th>
<th>UNED</th>
<th>OUNL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Prototype</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>• Period: November, 2003 – June, 2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Focus: LD Authoring Tool and LMS system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Report: D62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMS-LD Expert</td>
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<tr>
<td>Consortium Members using the Authoring Tool</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>Authors to evaluate the Authoring Tool</td>
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<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors to evaluate the LMS</td>
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<td></td>
<td></td>
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<td>Second Prototype</td>
<td></td>
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<td></td>
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<td>31</td>
</tr>
<tr>
<td>• Period: October, 2004 – February, 2005</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Focus: whole e-learning life-cycle.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Report: D63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors to evaluate the Authoring Tool</td>
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<td>2</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Learners</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Final System</td>
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<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>• Period: February, 2005 – April, 2005</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Focus: LMS system and adaptivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>• Report: D64</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Staff members: Administrator, Tutor, Auditor</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Learners</td>
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<td>11</td>
<td>25</td>
<td>11</td>
<td>(52)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>22</td>
<td>28</td>
<td>40</td>
<td>23</td>
<td>113</td>
</tr>
</tbody>
</table>

Table 2. Participation in Trials

A total of 10 trials with the participation of 113 persons was performed along the project.
4. Evaluation experiences along the e-Learning life-cycle

ALFANET has delivered a e-Learning system providing adaptive e-Learning capabilities to Learners. The platform supports adaptation through the e-Learning life-cycle and is made of four main subsystems: Authoring (Design phase), Administration, LMS eLearning Instruction subsystem (Use), and Auditing subsystem.

For the Design phase, ALFANET provides authoring tools that allow to design the course, making use of key e-Learning standards, namely:

- The LD Authoring Tool allows the course authors to generate e-learning courses based on IMS LD, including metadata IMS MD / IEEE LOM and generated the whole package as IMS CP.
- The QTI Authoring Tool supports the introduction of Metadata in the IMS QTI items and the generation of dynamic and adaptive questionnaires based on the Selection & Ordering specification provided by IMS QTI. It receives as input QTI items packaged with IMS CP.

For the phases of Administration, Use and Audit, ALFANET provides an integrated platform designed as a services based architecture that provides the platform with flexibility, modularity and extensibility capabilities.

Next we describe the evaluation results for each one of the components.

4.1 Design phase: Authoring Tools Evaluation

The Design stage, the first in the e-Learning cycle is in charge of defining didactic materials integrating the course. This phase is key in the process as it is responsible of one of the key factors in the success of e-Learning: quality of materials. Different e-Learning systems afford it through a set of integrated tools for the generation of contents. When these Learning Content Management Systems are based on the usage of e-Learning standards as IEEE-LOM, IMS-CP, SCORM, Contents can be reused in different courses, and can be understood by different e-Learning Management systems.

But what makes the difference between ALFANET and other e-Learning Systems is the adaptation. This makes also a difference at Design time, that is conceived to prepare the course for adaptation to different learners:

- Central in the ALFANET adaptation process is the design created in LD. The design contains the logic for the pre-designed adaptations and provides the hooks and the information upon which the runtime adaptation bases its reasoning.
- In order to design the course, the author can select one or more pedagogical models templates and apply them for the course at hand. These templates are a translation of the results of research in
learning and instructional design. Their objective is to ease authors the complex task of designing their courses.

- Since the author’s design is to be applied in runtime, norms to be monitored during the execution of the course and metadata to the activities and to the learning objects are needed to compare the real interaction with the author design and to provide the appropriate material according to the design.

Translating this to a practical approach, the creation of an Adaptive course within ALFANET follows the following steps:

- Definition of course structure and organisation according with the pedagogical template (Concept Learning Template).
- Creation of content materials. This is not supported in ALFANET, but can be done using other Authoring tools. It must be mentioned that ALFANET is able to import Learning Objects defined in other tools as well as other types of contents as hypertext documents, text documents, PDF format, etc.
- Special attention must be paid to the creation of Assessment which pay an special role in ALFANET adaptation. It is suggested to design the course with a set of questions (items) that will serve for the purpose of measuring the degree of understanding by the learner. ALFANET does not support the creation of question items and suggest the usage of a QTI compliant tool for the purpose of creating these items.
- Once the items are created, ALFANET provides a QTI Authoring Tool that allows the definition of dynamic questionnaires that can be adapted to each user depending on the user characteristics, course behaviour and questions metadata that is included also using the tool.
- Authoring the course with the LD authoring tool that supports the definition of the course components and method in IMS LD, generating the complete course package (IMS CP) that contains both the course definition and all the course resources (contents).
  - Adding rules for adaptation using the instruments provided by the LD Authoring tool in level B. LD definition could take advantage of information derived from QTI questionnaires. QTI assessment process is in charge of evaluating an exam and to generate a score value (or several score values) according to item definition. QTI process has not information in order to determinate whether an assessment is failed or not. Information about required score for passing an exam lies in LD design. For instance from adaptation point of view, it is very useful to know in which materials the learner has weakness, and to recommend additional materials in order to overcome such weakness. To do this it is necessary to generate several scoring variables in item definition time, and in LD definition to manage these variables in order to determine whether the learner has suitable level of mastery or not.
  - Adding metadata: The system contains mining tools to trace and identify usage patterns based on the actual interactions of the learners. A rule based engine filled with rules of thumb and pedagogical knowledge acts upon the patterns identified. If the author wants support for his learners by these rules, he needs to add the additional (meta)data to enable the rules. This includes adding data to QTI-items, LD-activities, Learning Objects (LO’s).

At the design time the author characterises learning objects according with the LOM educational attributes (Learning resource type, Interactivity level, Difficulty); technical attributes (format, duration), extended with usage (optional, mandatory, reinforcement) as keywords. Learning Objectives are also associated to the Learning Objects (let be by direct definition in the metadata catalogue entry).

The four Pilot sites have experienced the Design stage according with the above defined steps.

Overall we can say that the Design phase is experienced as a complex task. It requires specialised personnel to define the course, which involves having a global idea of the course (objectives and contents) and experience in use of systems for course definition.

In the particular case of ALFANET, these difficulties are more visible because of the following reasons:

- ALFANET incorporates Instructional Design, which requires knowledge on pedagogical methods, and on the Authoring tool implemented in the projects. LD design (LD Authoring) requires further refinement to be usable.
- The effectiveness of the Design process will be further improved with a set of integrated tools (current experience is based on the usage of independent tools) or a Design methodology.
4.1.1 LD Authoring Tool

Some lacks of usability were detected in the LD Expert Report (see ALFANET D62 Appendix 3.1.1), saying that the aesthetic conditions are good whereas usability conditions and Input/Output validation are low. But it must be taken into account that this study took place in a very early stage of the development and refers to the release version 0.0.3.01. Later versions optimised the tool considerably. The usability of the authoring tool is rated as Low-Medium (40%) during the first prototype trials.

<table>
<thead>
<tr>
<th>STRENGTH</th>
<th>WEAKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It makes independent the designer and the XML specification of IMS LD.</td>
<td>• It assumes a great deal of knowledge of IMS LD, and therefore the Authoring Tool requires much training</td>
</tr>
<tr>
<td>• The user interface is friendly.</td>
<td>• The complexity of LD concepts</td>
</tr>
<tr>
<td>• It is clearly structured.</td>
<td>• To create a course needs a lot of time due to the excessive number of items the author is required to insert.</td>
</tr>
<tr>
<td>• The tool generates alerts when errors occurs.</td>
<td>• Lack of logic in the workflow of the course. The editor is based on a technological view of learning design rather than an educational view.</td>
</tr>
<tr>
<td>• Provides the option to see a diagram of the course structure</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Strengths and Weaknesses of the Authoring Tool

The first three items mentioned as weaknesses cannot be considered as weaknesses of the tool. They refer to the conceptual complexity of IMS LD and the efforts regarding the structuring of material according to LD needs prior to working with the tool (items 1 and 2). The 3rd weakness mentioned is due to the variety of resources and metadata required for adaptive and personalized courses. It is not a weakness inherent to the Authoring Tool.

At the second prototype the usability of the authoring tool is rated as Low-Medium.

For improvement they suggested to have an integrated view of the tree structure and the templates you are working with. Most welcomed would be to have a wizard.

The design process is sometimes close to a software programming process. It is desirable to provide more support on the definition of the adaptation. The authors work with the authoring tool. Technical people prefers to write directly in xml code. The same problem is represented from two different points of view, and the communication is difficult when there are two different perceptions among users and development partners. There exists a need for pre-viewing the course published on intermediate stages of design, also when the course has incomplete parts.

One important feature requested by initial validations, the tree view that provides the option to see a diagram of the course structure, was positively accepted.

As summary, the tool is successful, but it does not hide the complexity of IMS-LD.

4.1.2 QTI Authoring Tool

The QTI Authoring tool was evaluated during the Second Prototype

Different partners used the QTI Authoring Tool to build self-adapting questionnaires. The tool received different items grouped in IMS-CP files and allows to select specific questions from them. To achieve this, metadata information is needed. The metadata characterizes each item, and this characterization information is later used to select specific questionnaires from a bank of items. Finally, in order to properly use the adapted questionnaire in the course, the scoring variables had to be defined in the LD, as well as those values used to check the metadata in run time.
UNED had some problems creating the items because Canvas Learning Author allows to define several items in the same xml file and the QTI AT only expects one item per file.

One KLETT author mentioned that he could not use the tool effectively because he did not understand the logical structure of the automated variability and the range of metadata. The study took place in an early stage. Then the manual described only the functionality provided, but use cases how to apply are missing. Nevertheless the author is satisfied with the quantity and quality of the developed content.

Efficiency would improve if an integrated help system and a manual with use cases were available. The author again complained that he did not understand what he was doing, therefore errors occurred (and were solved by trial and error); the memorability was low.

Better training and the improvement of the user manual has improved the satisfaction level.

Some other of the improvements suggested are:

- Include an integrated help system
- Improve the integration with QTI items authoring tools
- Improve the integration with LD authoring tools
- Improve robustness

4.1.3 Concluding Remarks

The design phase is a complex process. Different authoring tools (learning material production, questionnaires production, LD AT and QTI AT) have to be used. The courses were not completely defined by authors themselves, they needed the support of development partners. The author has not the needed skills/ extensive training to do it. The author has for example no idea of how to translate into the LD Authoring tool interface a simple adaptive rule (i.e. when the learner completes an assessment, depending on the result perform one or other activities). This is not only a matter of good training of authors, where special attention has to be given to the difficulties with defining the course in IMS LD at conceptual and at technological level. Also the lack of integration between the different authoring tools (learning material production, questionnaires production, LD AT and QTI AT) and between the authoring tools and the pre-view part of the LMS make difficult the definition of the course.

Authoring was not the main focus of Alfanet which is focused on adaptation at use phase but design phase is a requirement for adaptation and therefore a key point in Alfanet.

Further work have to be done about:

- Improvement and integration of the authoring tools.
- a user manual, explaining how to implement different adaptive scenarios instead of focusing on the typical use of menus. This activity has been already started, and the result is positively evaluated by users.

4.2 Administration and Publication phase

The administration phase of the system is supported by several services, namely: User Manager, Course Publisher, Course Manager, User Interface configuration and Recommendations Configuration:

4.2.1 User Manager

The User Manager is in charge of the definition of the system users and their characteristics. It provides the system with the initial basic user profile and defines an initial characterisation of the user based on several questionnaires that are proposed to the learner.

Some detected improvements for this functionality are:

- Improve the readability of the screen with the user data.
- To be consistent with the naming of the users and roles (learner/student, staff/professor/tutor), using the same name in all the components.
4.2.2 Course Publisher

The Course Publisher is in charge of preparing the run-time environment for the execution of a course by the learners: it stores the courses in the common repositories and informs to all the services about the course characteristics in order to allow them to generate the required data structures. Special attention must be paid to the Course Manager of the CopperCore service, which is in charge of the interpretation of the Learning Design in order to provide the needed data structures to allow to CopperCore to act as the LD Engine.

Several versions of the course were published from the beginning. The publication tool has been substantially improved along the project.

Some of the suffered problems:

- The publication operation had not realized successful, but there were not information about the occasioned problem. The validation operation had included with information of the different steps of checking process of the correction of IMS-LD of the course. It have been included information about occurred problems in the publication. More information have been included within the logs generated by the application.
- It is not possible to delete a course of the part of DOTLRN.

Identified improvements:

- To incorporate more information about the result of the publication in the DOTLRN environment in the logs generated by the application.
- To realize a validation more complete in the validation operation, that include every component that exist in the publication (load of objects in Tamino, in Coppercore, in DOTLRN, in QTI).

4.2.3 Configuration of User Interface

The User Interface configuration service allows all kind of users to personalise their interfaces by selecting the presentation templates that they want and personalizing more specific interface characteristics, as fonts, colours, etc.

Some of the suffered problems:

- The various possible configurations of the user interface are hard to handle by the students. The user interface is not sufficient intuitive and not related to the study processes and the structure of the course.

Identified improvements:

- The adaptability of the user interface should not be based on general considerations with respect to user interface building but derived from the study processes in the various courses and the choices students have to make.

4.2.4 Configuration of Recommendations

The Recommendator Administration allows authors or tutors to predefine static recommendations for a specific course. The recommendations are given to the learners when certain conditions of the course interaction take place.

Identified improvements:

- Filter the learning objects to select by objectives
- In the list of services to select, shown also folders and files.
- To define messages for some pre-defined events
4.2.5 Concluding Remarks
Evaluation activities in this phase have encountered problems of interoperability between IMS-LD definition delivered by the Authoring tool and the definition validated by the CopperCore (IMS-LD). These problems have been solved along the validation stage.

4.3 Use phase: Adaptive and Interactive components Evaluation

This phase focuses on the environment and tools available for the student and tutors while active within a course. From a high level point of view, the eLearning Instruction subsystem provides:

- A learning experience adapted to the individual characteristics of the learner.
- A structured learning environment with activities formalised in an instructional design and other more flexible environment for individual and collaborative work, when the learner (and potentially the tutor) can interact with the educational material and the virtual educational community in a more free way, but framed in an efficient learning environment, following his/her individual decisions (more learner oriented).
- Recommendations as support facilities suggested by the system.
- Support facilities provided by the tutor, or by the designer??.
- Facilities for tutoring the course (addressed to the tutor).

Following, a brief description of the adaptive and interactive components belonging to the eLearning Instruction subsystem:

4.3.1 General Interface and Personalization
The Presentation components provide a personalised, adaptive interface (e.g.: according with learner preferences), integrated and homogeneous presentation for the different services that configure an eLearning platform, and also other kind of applications that integrate one or more services. The adaptive presentation uses the User Model, based on IMS-IP.

Identified improvements:

- One opportunity for adaptation of the presentation is to show in the screen a limited number of items. Depending on the type of user different templates can be provided; for novel users to offer minimal info with some additional links.
- Within the course menus template, the images could be small or big and could also include alternate (ALT) text. This could be configurable by the learner.
- The Internationalization for some languages needs to be revised.

4.3.2 Learning Activities path
The Instructional Design (CopperCore) component provides the eLearning Platform with courses supporting different eLearning paths corresponding with concrete learner characteristics. It supports both the course administration (prepares the course to be used by different learners) and the interpretation of the defined course Instructional Design at the view of the User Model (IMS-LIP).

Some of the suffered problems:

- The double presence of the material, on the one hand presented in activities with a learning path chosen by the system; on the other hand as a bundle of free to choose learning material, is confusing.

Identified improvements:

- The learner locus of control based on well-structured learning content is more appropriate than the system learning control based on pre-assessment of particular learning style.
4.3.3 Interactive Services

The Interaction Services component supports individual and collaborative users’ tasks in terms of interactive services (forums, file storage area, agenda, etc) that are also included in the course definition. On the other hand, it provides an explicit representation of components to support their adaptive presentation. Moreover, it supports the administrative tasks to manage services and their use by learners and tutors.

Some of the suffered problems:

- There are visualization problems with special characters, only detected in the Spanish interface. This problem is suffered both for the user interface texts on the Interactive Services and for the texts introduced by the learner or tutor.

Identified improvements:

- One important improvement could be the integration of the services within the learning material portlet. The service within the portlet including a link to the related Interaction Service.
- More services for supporting the tutorization process will be welcome. These services will be mainly for monitoring the activities and the work performed by the learner. They could be provided by Interactive Services or by the Audit Service.

4.3.4 QTI Interpreter

The Evaluation and Assessment component provide support for the interpretation and presentation of dynamic adaptive questionnaires defined in IMS-QTI and their evaluation at run-time. It supports adaptive questionnaires that are generated dynamically at run-time according with different properties of the User Model (IMS-LIP) as the evolution of the learner in the course, the learner preferences, etc.

Some of the suffered problems:

- The assessment questions are presented in a very rigid way.

Identified improvements:

- The interaction design of the QTI assessment module should be improved.

4.3.5 User Model and Recommendations Provided: the Adaptation Module

The Adaptation component provides recommendations and advises to learners while interacting with a course based on the experience derived from previous users’ interactions. In addition it supports for the adaptive functionality of the Instructional Design interpreter, the Interaction Services and the Presentation layer. User Modelling, Machine Learning and Multi-Agent Architecture are the technological bases of this innovative package.

Some of the suffered problems:

- Some links that appears on the recommendations portlet produce an error

Identified improvements:

- One interesting improvement could be to integrate recommendations within the associated portlets; for example the recommendation “see the course objectives” could be showed as a stress in the learning objectives link.
- Feedback to the learner: the system could offer to the learner information about the current progress in the course objectives as well as the monitorisation of the activities performed. Also these functions can be provided in the context of the Audit module.

4.3.6 Concluding Remarks

The outcomes from evaluation activities at Use phase are:

- The effectiveness of the LMS is rated positive. It is possible to reach the learning objectives with the Alfanet system.
- The efficiency is rated less positive. The participants suffered performance problems.
• The usability and navigation using the current interfaces is seen as a weak point. Nevertheless it is noted that the personalization and the possibility of defining different presentation templates may help to fix this problem. Experiences with the course menus template are rated as more positive. Although the adaptivity of the system regarding recommendations is not sufficiently evaluated, important feedback and suggestions for improvement has been collected. The improvements implemented in the last months are also rated as very positive by the users partners.

4.4 Audit Phase: feedback to design phase

Auditing closes the e-Learning cycle. It collects data depending on the author’s requirements on the actual use of the course and presents them to the author in a clear way (e.g. study hours for a given learner and activity). The author gets reports from which the author can derive conclusions about design, showing how successful the course design has been and to what extent the objectives and norms that were stored in the design, have been reached. Therefore, depending of the outcome he or she can decide if there is a need to reconsider the design.

The Audit functionality, can be summarized as:

• Data analysis and reports: It consists on a component that is in charge of the user interactions and other information analysis in order to provide complete reports about each course and users results.
• Users satisfaction statistics, providing a quick overview of users satisfaction when the course is finished.
• The consultation of questionnaires that have been performed by the learners.

The outcomes from this stage can be summarised as:

• Participants think positive about the usefulness and supportiveness of the concept of auditing in future, but it cannot replace talking with students.
• Participants rate the effectiveness of the this prototyped module negative: they cannot produce all audit reports wanted, only a fixed set of basic reports is available. They prefer audit reports that provide information about results of examinations and dynamic data related to learning paths chosen by students. A number of dynamic reports have been added in the ultimate version of the audit module to cope with these remarks.
• Participants are not satisfied with the quality of the produced audit reports, because the reports still produce raw data instead of valuable information that can be used for improvement of courses.
• Participants find it easy to learn to handle and use the audit module, but remark the limited possibilities of reports in this prototype.
• The satisfaction statistics are interesting for understanding the opinion of learners in relation with contents, methodology, adaptation and tutoring staff.
5. Adaptation Assessment Results

Adaptation in the context of eLearning is about creating a learner experience that purposely adjusts to various conditions (e.g. personal characteristics, pedagogical knowledge, the learner interactions, the outcome of the actual learning processes) over a period of time with the intention of increasing pre-defined success criteria (e.g. effectiveness of e-learning: score, time, economical costs, user satisfaction).

Adaptation is not an idea that can be plugged in a learning environment, but it influences the full life cycle of the learning process, as described in the above section.

The adaptive features provided by ALFANET system are classified into four main categories corresponding with the main components of the system: Presentation, Learning Route from Design, Recommendations during the Interaction and Dynamic Adaptive Assessment. These adaptive features are complemented with the Feedback to the author provided by the Audit Component.

The adaptivity of the system regarding recommendations is mainly evaluated considering the UNED Pilot site.

At this section we aim to:

1. Test that the adaptive functionality is correctly implemented.
2. Report if this adaptive functionality was used by the users.
3. Evaluate the user satisfaction for each one of the adaptive features included (using the usability questionnaires).

<table>
<thead>
<tr>
<th>Adaptive Feature (category)</th>
<th>Adaptive Feature</th>
<th>correct</th>
<th>used</th>
<th>Satisfaction Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>Personalised Presentation</td>
<td>Yes</td>
<td>Yes</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Adaptive Presentation</td>
<td>Yes</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Learning Route from Design</td>
<td>Pedagogical Model: Concept Learning Template</td>
<td>Yes</td>
<td>Yes</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Pre-designed adaptations rules</td>
<td>Yes</td>
<td>Yes</td>
<td>Medium</td>
</tr>
<tr>
<td>Recommendations during the Interaction</td>
<td>Recommend an interaction</td>
<td>Med</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Create and present motivation messages</td>
<td>Med</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Support the peer-to-peer collaboration</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>User modelling tasks</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diagnosis tasks</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Adaptive Assessment</td>
<td>Self-assessment</td>
<td>Yes</td>
<td>Yes</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Lesson and Final Assessment</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remediation Assessment</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Feedback to the author</td>
<td>Audit Reports</td>
<td>Yes</td>
<td>Yes</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Table 4.- Evaluation of Adaptive Features

Satisfaction level evaluated by filling electronic questionnaires by the learners:

<table>
<thead>
<tr>
<th>Prototype</th>
<th>KLETT</th>
<th>EDP</th>
<th>UNED</th>
<th>OUNL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction on Adaptation features</td>
<td>45%</td>
<td>48%</td>
<td>66%</td>
<td>40%</td>
<td>50%</td>
</tr>
</tbody>
</table>
6. Conclusions

6.1 Design phase

The design phase is a complex process. Different authoring tools (learning material production, questionnaires production, LD AT and QTI AT) have to be used. The courses were not completely defined by authors themselves, they needed the support of development partners. The author has not the needed skills/ extensive training to do it. The author has for example no idea of how to translate into the LD Authoring tool interface a simple adaptive rule (i.e. when the learner completes an assessment, depending on the result perform one or other activities). This is not only a matter of good training of authors, where special attention has to be given to the difficulties with defining the course in IMS LD at conceptual and at technological level. Also the lack of integration between the different authoring tools (learning material production, questionnaires production, LD AT and QTI AT) and between the authoring tools and the pre-view part of the LMS make difficult the definition of the course.

Authoring was not the main focus of Alfanet which is focused on adaptation at use phase but design phase is a requirement for adaptation and therefore a key point in Alfanet.

Further work have to be done about:

- Improvement and integration of the authoring tools.
- the user manual, explaining how to implement different adaptive scenarios instead of focusing on the typical use of menus. This activity has been already started with the adaptive scenarios described in D65, and the result is positively evaluated by users.

6.2 Administration and Publication phase

Evaluation activities in this phase have encountered problems of interoperability between IMS-LD definition delivered by the LD Authoring tool and the definition validated by the CopperCore (IMS-LD). These problems have been solved along the validation stage.

6.3 Use phase: Adaptive and Interactive components Evaluation

The outcomes from evaluation activities at Use phase are:

- The effectiveness of the LMS is rated positive. It is possible to reach the learning objectives – depending on the quality of the course contents - with the Alfanet system.
- The efficiency is rated less positive. The participants suffered performance problems.
- The usability and navigation using the current interfaces is seen as a weak point. Nevertheless it is noted that the personalization and the possibility of defining different presentation templates may help to fix this problem. Experiences with the course menus template are rated as more positive.

Although the adaptivity of the system regarding recommendations is not sufficiently evaluated, important feedback and suggestions for improvement has been collected.

The improvements implemented in the last months are also rated as very positive by the users partners.

6.4 Audit Phase

The outcomes from this stage can be summarised as:

- Positive usefulness and supportiveness of the concept of auditing. It provides also valuable information for the tutoring process, but it cannot replace talking with students.
- The effectiveness of this module can be improved by increasing the number of reports. Some missed assessment results for the second prototype are now implemented for the third prototype; the dynamic data related to learning paths chosen by students are now implemented.
- Regarding satisfaction, participants says that the reports produce raw data and they should offer better visualised information that can be used for improvement of courses.
- The audit module is easy to learn, to handle and use.
- The satisfaction statistics are interesting for understanding the opinion of learners in relation with contents, methodology, adaptation and tutoring staff.

### 6.5 Strengths of the ALFANET System

As strengths of the Alfanet system students mention:

- Dynamic Adaptivity and Recommendations supplied, the adaptation scenarios defined in the D65. were positively rated by user partners.
- Flexibility of task order
- Residing on the internet. All information is available and can be updated. The information can be accessed more easily than using books.
- Variety of different exercises and assessments
- Good guidance and feedback by the use of tests. Interactivity and direct self-assessment of the level of understanding of the course material.
- Course material is adapted at your own learning profile.

ALFANET strength is built on the components design based on existing IMS standards, thus providing support for the full e-Learning cycle, completing it with the feedback to the author. Among the advantages of the standard based systems is that they allow the tracing of the tutoring-learning process. On the other hand, the standardization guarantees that the product will not become obsolete in a short time, saving the investments made.

### 6.6 Concluding Remarks

The consortium is aware of the ALFANET powerful as described in the strengths (last section); but also the weak points are detected during the evaluation process. This report provides the basis for further development of ALFANET components, offering summary conclusions from the experiences gathered at the different stages of the eLearning life-cycle.

Next we outline some of the learned lessons from the evaluation activities.

- The Design phase is experienced as a complex task. It requires specialised personnel to define the course, which involves having a global idea of the course (objectives and contents) and experience in use of systems for course definition. In the particular case of ALFANET, these difficulties are more visible because ALFANET incorporates Instructional Design, which requires knowledge on pedagogical methods, and on the Authoring tool implemented in the projects.
- The effectiveness of the Design process would be further improved with a Design methodology and a set of integrated tools (current experience is based on the usage of independent tools), mainly between the LD and QTI Authoring Tools and between LD Authoring Tool and LMS for preview purposes.
- The knowledge obtained from the project is now consolidated and it is explicit within the guides delivered at D32 and D65 reports.
- Currently, the facilities addressed to the authors for define the adaptation within a course are substantially increased (configuration of recommendations, refinements of the conditions within the LD Authoring Tool, etc). Nowadays there is still necessary a technical knowledge and skills in order to orchestrate successfully the course flow (taking into account questionnaires results and settings of variables).
- Experiencing adaptation requires an open design that provides diversity in learning materials and open learning paths. It also requires to give freedom to the learner to accept or not the recommendations: acceptance reinforces the utility of the recommendation.
- Main user characteristics that are considered to provide adaptation are Cognitive Modality (CM visual / verbal), Learning Style (LS inductive deductive), Interest, Knowledge level (achievement level of learning objectives). Other relevant characteristics used are level of activity and similarity between learners. During the project other users characteristics have arisen which are relevant for providing adaptation.
Appendix 1 References


