

# GRAPPLE

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## Requirements Specification by Academic Users on Integrated Adaptive Learning Services

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### Abstract:

This deliverable documents the stakeholder interviews in the academic setting. Adaptive features and dimensions were presented to learners and training providers through usage scenarios in order to elicit from them, which features and dimensions are key to an adaptive learning system.

### Keyword list:

Academic setting, LMS, adaptation, personalization, requirements

## Summary

Deliverable D9.1 (Requirements Specification by Academic Users on Integrated Adaptive Learning Services) and the closely related Deliverable D10.1 (Requirements Specification by Corporate Users of LMS on Integrated Adaptive Learning Services) have been produced for the EU FP7 STREP project, GRAPPLE (Generic Responsive Adaptive Personalized Learning Environment). The GRAPPLE project aims at delivering to learners a technology-enhanced learning (TEL) environment that guides them through a learning experience, automatically adapting to personal preferences, prior knowledge, skills and competences, learning goals and the personal or social context in which the learning takes place. The same TEL environment can be used at home, school, and work or on the move (using mobile/handheld devices). The scope of this deliverable is to detail the requirements to be met by a set of adaptive learning services

that will be integrated with existing Open Source and commercial Learning Management Systems (LMSs) for academic users.

The purpose of this deliverable is:

- To briefly detail the requirements elicitation methodology used;
- To elicit from the stakeholders which features are key to an adaptive learning system through user interviews; and
- To ensure target oriented work from the beginning of the project.

The main contributions of this deliverable are:

- A demo scenario of adaptive learning systems, that stems from the experience of the GRAPPLE partners and helps clarify and focus interviewees on the features and dimensions of adaptivity;
- The capturing of key adaptivity requirements through user interviews;
  - In particular, we have compiled a 'most-wanted' list of specific features and dimensions of adaptivity (

	<i>No.</i>	<i>Min.</i>	<i>Max.</i>	<i>Mean</i>	<i>S.D.</i>
<b>Learner Knowledge</b>	<b>26</b>	<b>6</b>	<b>10</b>	<b>8.85</b>	<b>1.190</b>
<b>Learning Goal/Task</b>	<b>27</b>	<b>4</b>	<b>10</b>	<b>8.70</b>	<b>1.815</b>
<b>Language</b>	<b>26</b>	<b>5</b>	<b>10</b>	<b>7.96</b>	<b>1.455</b>
Platform	26	3	10	7.77	1.583
Interests	27	2	10	7.22	2.136
Learning/Cognitive Style	27	2	10	7.19	2.403
Student Qualification	26	3	10	7.15	1.974
User Role	27	1	10	7.00	2.370
Motivation	27	1	10	6.96	2.682
Personal Preferences	27	1	10	6.26	2.474
User Location	27	1	10	6.04	2.361
Background	27	1	10	5.30	2.367
Personality Factors	27	1	8	5.07	2.368
Experience in Hyperspace	26	1	10	5.00	2.561

- Table 18 and Table 23) as ordered by their mean ratings. The most prominent features of adaptivity in descending order as rated by the interviewees include adaptation to learner knowledge, learning goal/task, language, platform, interests, learning/cognitive style, student qualification and user role.
- On the other hand, the most prominent dimensions of adaptivity in descending order as rated by the interviewees include adaptive learning activity selection, adaptive content selection (especially additional explanations, prerequisite explanations and comparative explanations), adaptive problem solving support (especially intelligent analysis of solutions and example-based problem solving), student model matching (especially adaptive collaboration support and intelligent class monitoring) and adaptive presentation.
- The observation that both learners and training providers consider the authoring of an adaptive course difficult and complex and hence, appropriate authoring tools with comprehensive authoring advice and help should be provided.

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## List of Acronyms and Abbreviations

ALE	Adaptive Learning Environment
AH	Adaptive Hypermedia
GRAPPLE	Generic Responsive Adaptive Personalized Learning Environment
LMS	Learning Management System
PAE	Personal Authoring Environment
PLE	Personal Learning Environment
PTE	Personal Tutoring Environment
TEL	Technology-Enhanced Learning
WP	Work Package

### 1 Introduction

The GRAPPLE project aims at delivering to learners a technology-enhanced learning (TEL) environment that guides them through a learning experience, automatically adapting to personal preferences, prior knowledge, skills and competences, learning goals and the personal or social context in which the learning takes place. The same TEL environment can be used at home, school, and work or on the move (using mobile/handheld devices). This section describes the scope and objectives of the deliverable.

A key component of the GRAPPLE project is its integration with existing Open Source and commercial LMSs. To ensure target-oriented work from the beginning of the project, the personalization and adaptation needs of users were collected in a systematic form. This deliverable is concerned with the academic users. A related deliverable, Deliverable D10.1, covers the corporate or industrial users. The aggregated results of these interviews will form a basis for research in (WP1-WP7). The results will also prioritize the features that the users deem most important to include in an adaptive learning system.

The objectives of this deliverable are:

- To briefly detail the requirements elicitation methodology used;
- To elicit from the stakeholders which features are key to an adaptive learning system through user interviews; and
- To ensure target oriented work from the beginning of the project.

The requirements gathering stage will be followed by appropriate documentation and training for GRAPPLE users (Deliverables D9.2 and D9.4) and an empirical evaluation in higher education settings (Deliverables D9.3 and D9.5) to evaluate the utility of an adaptive learning system based on user trials.

An outline of each of the remaining sections of this deliverable is provided:

Section 2 briefly describes the requirements elicitation methodology. We present the demo scenario from the point of view of a learner, tutor and author. A more thorough treatment of the requirements elicitation and analysis methodology can be found in Annex A.

Section 3 describes the interviews with the learners and training providers. In particular, it discusses their responses to the demo scenario; their current usage of learning systems (both adaptive and non-adaptive) and it enumerates the various features and dimensions of adaptivity. We step through and explain each question and summarize the results as provided by the interviewees.

Section 4 analyzes the interviews by summarizing the responses of our interviewees and, using the relevant open-ended and closed questions, prioritizes the features and dimensions of adaptivity.

Section 5 draws some conclusions and describes the relevance of this deliverable to the GRAPPLE project.

## 2 Requirements Elicitation Methodology

In this section we briefly describe the requirements elicitation methodology for academic users. We present the demo scenario as it was described to the stakeholders. We step through and explain the questions of the interview and summarize the results. In doing this, we enumerate the objectives of adaptivity (what we can adapt to) and objects/dimensions of adaptivity (what we can adapt). Attempting to realize such a large amount of adaptivity demands simultaneously may result in contradictions and may be overwhelming to the learner and developer of the system. The results of our user interviews help to prioritize these adaptivity features and dimensions.

### 2.1 Description of Methodology

The purpose of the requirements elicitation is to gather personalization and adaptation needs of academic users. For the sake of eliciting user requirements a requirements analysis methodology was developed in WP8 (see Annex A). This methodology contains the development of an interview guide for semi-structured interviews with stakeholders. The academic stakeholders are divided into three groups: learners, training providers and others. The first group consists of students, both undergraduate and postgraduate. The second group consists of lecturers and tutors who are responsible for the provision and teaching of courses. The last group consists of researchers and developers who are interested in learning systems but do not use them for teaching or learning *per se*. The interview guide and protocol can be found in Annex A.

Once all the interview data had been gathered, the data was aggregated. Taxonomy of possible answers for the open-ended questions was derived. The data was analyzed using descriptive statistics and frequency counts. An analysis of these results is provided in Section 4.

### 2.2 The Demo Scenario

Before conducting the interviews, a demo scenario was sent to the interviewees. This scenario illustrated the typical usage of adaptation by a student, tutor and author, personified by Anna, Peter and Martin respectively. It provided the interviewees with a basic understanding of adaptivity. The interviewees were encouraged to estimate the relevance of each use case to their own personal context and work. The scenario is described in the remainder of this section.

#### 2.2.1 Student

Anna studies at a university. Her tutor (teacher) Peter identifies her learning objectives together with her. Being aware of Anna's competences and preferences, Peter can identify a suitable learning plan for her, which is then delivered to her via the Personalized Learning Environment (PLE). Based on Anna's prior knowledge and the prerequisites for the selected plan, the PLE retrieves a pre-assessment for Anna to identify her knowledge gap more precisely. The PLE uses Anna's learner profile (including her knowledge level, skills, and preferences), pre-assessment results, and the defined plan to retrieve relevant units of learning and delivers them to Anna. The delivery of the content (like its selection and ordering, media presentation, navigation support, choice of co-learners, method of interaction, recommendation of additional resources) is adapted according to Anna's learner profile as well as the current context (including the delivery device and current learning strategy - like deep study or quick repetition). When she is following an online lecture on her desktop computer and must leave for another appointment, she can continue following

it on the bus via her mobile device. If she has missed something, she can get it on demand later in her preferred format (e.g. video, audio pod-cast, presentation, etc.). When Anna completes her units of learning, the PLE delivers a post-assessment to her. The PLE grades Anna's post-assessment and delivers the results to her and Peter. If needed, Peter prepares a new learning plan for Anna to fill the remaining knowledge gaps. Otherwise, they specify new learning objectives for Anna and follow the procedure anew.

### 2.2.2 Tutor

Peter teaches at a university and Anna is one of his students. Taking into account her abilities and interests, he can recommend her appropriate learning plans to reach her learning objectives. Peter supports his students by supervising them and giving them guidance. His tasks include answering learners' questions, assessment of learners' contributions, monitoring and assessment of their progress, and group support. To facilitate communication with students he uses the Personalized Tutoring Environment (PTE), providing him with visualizations of the learning processes and progress in order to examine social, cognitive, and behavioral aspects of students, together with required functionality - monitoring, assessment, and student feedback. Peter does not have to respond to each student question, as many peers with the relevant knowledge can provide answers. He intervenes only when necessary (e.g. no answer comes in a certain time limit or the discussion takes a wrong direction). Peter can choose which characteristics are relevant for him and what is his preferred means of their visualization. He can set up a notification mechanism to be informed of relevant events in the system (e.g. when someone has problems and needs help). If Anna finds the recommended learning plan difficult to follow, Peter recognizes her problem and recommends a more appropriate alternative for her. He may also notify the authors of problematic learning plans or resources about the issues found out in the practice.

### 2.2.3 Author

Martin creates learning plans (i.e. learning designs consisting of structured learning activities referring to learning materials) for university courses. His colleagues teaching similar courses may also use the plans or parts of them. He aims at development of learning plans that will be delivered to students in a personalized and adaptive way (providing alternative paths through the plan for different learners). He has already the basic fragments of text, drawings, photos, animations, audios, and videos, even specifications of learning activities and designs that can be used. Martin either found them in available repositories or created them before with various production tools. Now, he wants to compose a new learning plan out of them and for this purpose he uses the Personalized Authoring Environment (PAE), which is based on learning standards to enable exchange of components among applications and systems. Re-usability and interoperability are crucial requirements to make the authoring efficient. This means that one pedagogical method can be used in various situations with different learning resources. Or to put it differently, alternative pedagogical strategies can be applied over the same learning resources (e.g. for beginners and advanced students, for deep study as well as quick repetition). Interoperability of adaptive systems would be enabled by a specification clearly describing the educational role of each component, and how the components relate to each other (e.g. prerequisite or alternative relationships). The specification should enable knowledge representation (e.g. creation of rules) to describe how the delivery of the learning experience (e.g. presentation of the content or provision of supporting services) should be adapted to the needs of the individual learner (e.g. if the learner has high inductive reasoning then show concrete examples before conceptual material; if the learner has high social skills then offer her synchronous interaction with her peers). To create an adaptive learning application various types of knowledge need to be used, e.g. knowledge about domain, pedagogy, learner, context, adaptation. Ideally the author can distinguish various types of knowledge and represent them separately (as conceptual entities with explicit semantics). However, Martin does not have to formalize all of them, as using suitable metadata; he may find in existing repositories the components he needs. If they do not fit exactly to his requirements he can adjust them accordingly. To make the authoring process easier and more intuitive PAE provides automatic help and templates for specification of learning resources, their attributes and relationships. Some of the attributes (metadata) may be generated automatically via the inheritance mechanism (e.g. target group, difficulty level) or from the current context (e.g. author, time of creation). The PAE also supports collaborative authoring, providing suitable communication and awareness raising facilities for authors.

## 3 Interviews with Academic Users

In this section we present the interviews. We step through and explain the questions and summarize the results.

### 3.1 Introduction

The interviews were conducted during June 2008 by seven European institutions. There were 27 interviews in total: 8 with learners, 17 with training providers and 2 with others (researchers and developers). Table 1 and Table 2 provide a summary of the academic interviews. The learners were undergraduate and postgraduate students from various fields. The training providers were lectures and tutors. The two remaining interviews were researchers/developers in the field of learning systems. In the following sub-sections, we also analyze some of the answers by stakeholder group (i.e. learner, training provider or other) where appropriate.

The limited sample size used in the conduction of the stakeholder interviews requires the results and conclusions derived from them to be treated with some care. We may not overly generalize the results if our sample is not highly representative of the complete population. However, there are reasons for the chosen sample size, which are predominantly due to the data collection instrument selected for our purposes and the involved efforts.

The utilization of semi-structured interviews for requirements elicitation was found to be the most appropriate instrument. In general, interviews prove to be highly suited for establishing a comprehensive understanding of stakeholders' opinions and needs. The decision to realize semi-structured interviews ensured, on the one hand, to have a common ground for the interviews to be conducted in a distributed manner by different project partners, and on the other hand it allowed an explorative data gathering process. The private face-to-face conversations ensured the interviewees' understood the concepts of adaptivity and allowed a comprehensive and detailed discussion of users' needs and preferences.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
TUE	0	4	0	4
OUNL	2	6	2	10
VUB	1	1	0	2
WARWICK	1	1	0	2
USI	1	2	0	3
UniGraz	2	1	0	3
TCD	1	2	0	3
<b>Total</b>	8	17	2	27

Table 1: Summary of the academic interviews.

	<i>Frequency</i>	<i>Percent (%)</i>
Learner	8	29.6
Training Provider	17	63.0
Other	2	7.4
<b>Total</b>	27	100.0

Table 2: Frequency of interviews per stakeholder group.

However, carrying out interviews is quite laborious and time-consuming, especially when the interviews are not completely standardized. Individual conversations need to be conducted with each interviewee within an according time allocation to ensure the possibility of a thorough and productive discussion on all the issues foreseen in the interview guide. Interviewers needed to prepare for the interviews and also needed to perform follow up work consisting of note-taking, preparation of interview summaries, and of course, the

recording of the elicited data. The content analysis of open answers gathered in the interviews also constitutes a work-intensive process.

Given these predictably high demands in carrying out the stakeholder interviews (compared to other sorts of data collection), a limited number of interviews was planned and realized. The number of interviews to be conducted by the project partners was proposed in accordance with the planned number of person-months in the respective work-package (WP9 for university settings and WP10 for business settings). By distributing the interview conduction over all partners, data from a broad range of different interviewees' could be guaranteed - coming not only from different countries but also from different backgrounds. Therefore, it can be assumed that the interviews conducted provide some valuable insight into the general population. Future investigations at the evaluation stages of the project will allow data collection instruments that provide for larger sample sizes.

### 3.2 Response to Demo Scenario

As detailed in Section 2.2, all the interviewees were asked to read through an initial scenario relating to adaptive learning prior to the interview and rate its relevance to their personal context and work. Interviewees generally found the demo scenario a useful introduction to adaptivity and also during the interview; it was helpful when describing certain concepts of adaptivity. We briefly mention some of the more interesting comments made by the three stakeholder groups with respect to the demo scenario.

Unsurprisingly, the learners could relate best with the learner role (Anna). However, many found the other use cases more difficult to understand; in particular the differentiation between the tutoring (Peter) and authoring (Martin) roles: *'the other scenarios were more difficult to understand, especially without a lot of background information on adaptivity and online learning applications.'* One learner also pointed out that the tutor has to sufficiently understand the student's learning objectives in order to elaborate a suitable learning plan and he felt that they did not have the time and resources to do this properly. Other learners confirmed this viewpoint by saying that *'authoring is a demanding task that should be done by a team'* and that *'there is no such thing at university as individualized support; ... we are no more than numbers'*.

Training providers in general appeared to be more familiar with all three roles and could relate to the tutoring (Peter) and authoring (Martin) roles. In particular, only one training provider reported any problem in differentiating between tutors and authors. Another training provider cited the lack of a formal definition language for defining learning objectives as a limiting factor. The training providers, like the learners, appreciated the difficulty in authoring an adaptive course: *'the authoring use case does not say anything about the complexity of the process if adaptive learning is the aim'* and *'the scenarios pre-suppose many resources in time and workforce, which is not the case in my institution'*. Another training provider would have liked to see a list of what problems have been solved and what problems have not with respect to adaptive learning systems.

The interviewees, who were neither learners nor training providers, but researchers and developers in the area of learning systems, naturally understood the scenario. One also pointed out that the three roles may overlap to some degree and that this should be a factor when designing the system.

### 3.3 Current Usage of Learning Systems

The first section of the interview gauged the current usage of learning systems and adaptive learning systems by the interviewees. We present each question in turn and summarize the results.

#### A1. Do you use any learning systems?

This was a direct yes/no question. Out of 27 interviewees, a majority of 25 are using or have used learning systems (see Table 3 for details). All interviewed training providers have experience with learning systems. Only two learners indicated that they have no experience.

	Yes	No
Learner	6	2
Training Provider	17	0
Other	2	0
<b>Total</b>	25	2

Table 3: Usage of learning systems per stakeholder group.

### A2. Which learning systems?

This was an open-ended question; we did not provide a list of learning systems to choose from. In the case of customized or heavily modified systems, we grouped these under the category 'in-house'. Other than in-house systems, Moodle and Blackboard were the most popular learning systems (see Table 4).

This question also provided us with information as regards to the number of learning systems in use by each interviewee. On average, each interviewee used two learning systems (mean = 2.04, standard deviation = 1.26 with a range from 0 to 5). Training providers indicated that they use significantly more learning systems ( $t(23) = 2.699, p = 0.013$ ), with training providers listing on average 2.5 (standard deviation = 2.47) systems and learners listing on average 1.1 (standard deviation = 0.9) learning systems.

In-House	13
Moodle	12
Blackboard	9
Sakai	3
WebCT	3
AHA!	1
ALEKS	1
BBC course example system	1
Dokeos	1
Educativa	1
Ilias	1

Table 4: The learning systems used by interviewees (in descending order by use).

### A3. How often?

This question was initially open-ended but after the interview the answers were categorized as either daily, once to several times a week, once to several times a month, once to several times a year or hardly ever. Table 5 and Figure 1 summarize the results. Most training providers use learning systems daily or once to several times a week, whereas learners seem to use them less frequently.

	Learner	Training Provider	Other	Total
Daily	0	8	0	8
Once to several times a week	2	6	2	10
Once to several times a month	3	0	0	3
Once to several times a year	1	2	0	3
Hardly ever	0	1	0	1
<b>Total</b>	6	17	2	25

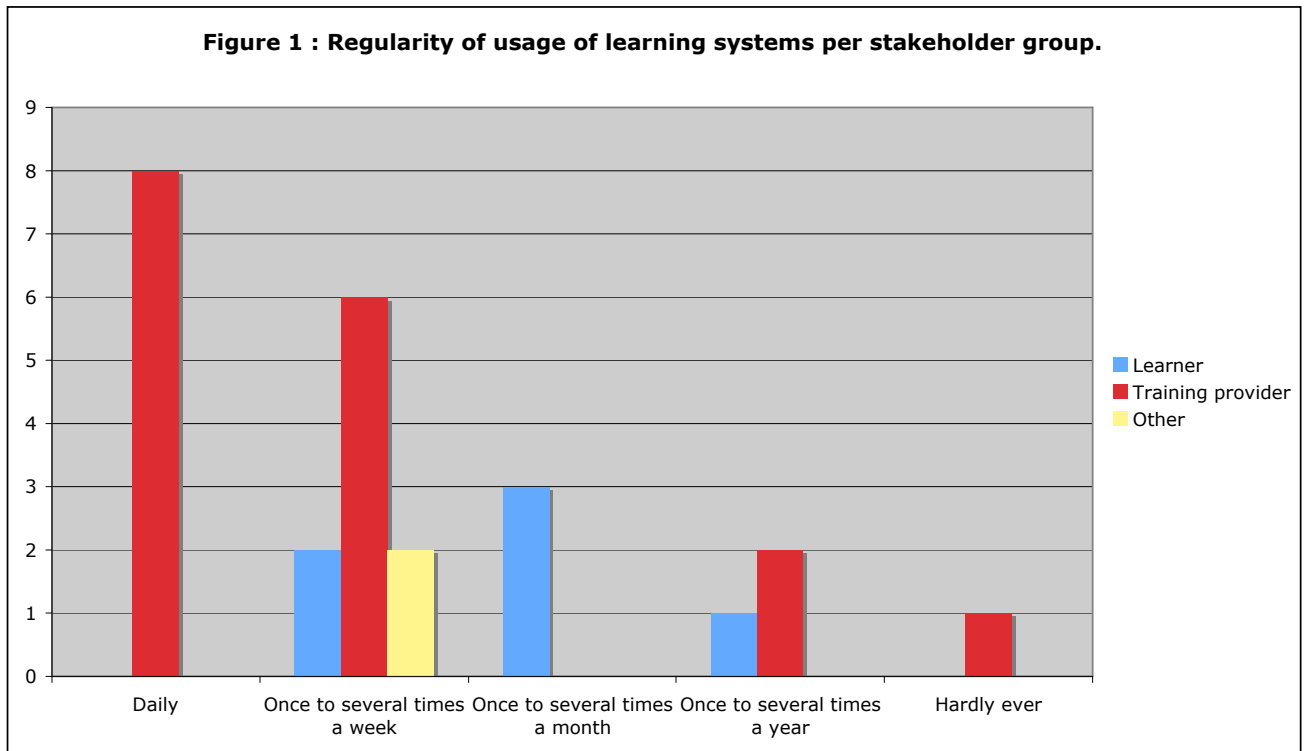
Table 5: Regularity of usage of learning systems per stakeholder group.<sup>1</sup>

#### A4. How long have you been using learning systems?

Another indication of a user's experience with learning systems is the duration for which they have been using them. Training providers appear to have long-term experience in using learning systems; while learners have been using those more recently (see Table 6 for more details). To summarize the results of the previous four questions, the interviewed training providers are in general more experienced than the learners with respect to the use of learning systems.

#### A5. Does the learning system you have used so far provide any features of adaptation or personalization to users?

This question investigates the provision of adaptivity and personalization features in existing learning systems. The results (Table 7) show that the majority of learning systems have no adaptivity or personalization features. The weak support of adaptation by Open Source and commercial LMSs has been confirmed in the literature [4].



<sup>1</sup> Two learners did not provide answers to questions A3 and A4, so the total number of interviewees for these questions is 25 instead of 27.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
For years	1	13	2	16
For about 1 year	2	3	0	5
For months	3	1	0	4
<b>Total</b>	6	17	2	25

Table 6: Duration of usage of learning systems per stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
No	4	10	1	15
Yes	2	7	1	10
Does not apply	2	0	0	2
<b>Total</b>	8	17	2	27

Table 7: The presence of adaptation or personalization features in learning systems as used by each stakeholder group.

#### A6. Which?

In an open-ended question, we asked the interviewees to list the adaptation or personalization features (if any) that are present in their learning systems. Table 8 lists these features in descending order by the number of interviewees who said so. Interviewees mentioned adaptive navigation (adaptation at the link-level), adaptive content and personalization most often.

Adaptive Navigation	5
Adaptive Content	3
Personalization	3
Reminders	2
Adaptive Annotation	1
Adaptive Presentation	1
Community Personalization	1
Multi-lingual	1
Personal Work-spaces	1
Personalized Feedback	1
Prerequisites	1
Progress Indicators	1
Resource Assignment	1
Interface	1

Table 8: The adaptation or personalization features used by interviewees in learning systems (in descending order by the number of interviewees who said so).

#### A7. For what purpose or task are you using (or would you use) a learning system?

The answers to this open-ended question were again grouped to produce the categories in Table 9. Peer support and collaboration, distribution and the material organization of a course were deemed the most important by the interviewees.

Peer Support and Collaboration	8
Distribution	6
Material Organization of Course	6
Introducing New Material	5
Supervision/Monitoring	5
Blended Learning	3
Teacher-Student Communication	3
Testing	3
Calendrical Organization of Course	2
Individual Study	2
Interactivity	2
Supporting Tool	2
Distance Learning	2
Resource Provision	2

Table 9: The purposes for which learning systems are used (in descending order by the number of interviewees who said so).

**A8. What are the benefits of using a learning system?**

In a similar vein to question A7, the interviewees were asked to list the benefits of using a learning system. These answers would presumably reflect the actual reasons they use a learning system and, from the answers, this proved to be the case. Table 10 summarizes the results; communication, a centralized source of material and the re-usability of learning materials were mentioned most often. These reflect the top three answers of the previous question.

Communication (including feedback)	9
Centralized Source of Material	8
Re-usability of Learning Materials	6
Efficiency	5
Tracking/Progress Monitoring	5
Collaboration	4
Distribution	4
Course Overview	3
Distance Teaching/Learning	3
Persistence (e.g. instead of email)	3
Testing	3
Calendrical Organization	2
Synchronous/Asynchronous Teaching	2
Multimedia	1

Table 10: The benefits of learning systems (in descending order by the number of interviewees who said so).

### 3.4 Adaptivity Needs and Preferences

The second section of the interview focused more on adaptivity and the purposes and benefits of an adaptive learning system (whether the interviewee had previously used one or not). We present each question in turn and summarize the results.

#### **B1. What do you think are the purposes or tasks for which the use of an adaptive learning system is especially suited?**

This open-ended question was the adaptive analogue of question A7. Table 11 summarizes the results. The top two answers were individualized teaching and guided, individualized learning. These can be considered the same purpose, but from opposing viewpoints, i.e. the training providers' and learners'. Providing the details of technical material that are too cumbersome to present in a lecture or class, for example the details of the more obscure libraries and functions of a programming language, also featured quite prominently.

Individualized Teaching	6
Guided, Individualized Learning	5
Details of Technical Material	4
Clearly Defined Knowledge Domains	2
Identifying Strengths/Weaknesses in a Student	2
Monitoring	2
Procedural/Vocational Training	2
Assessment	1
Basic Training	1
Calendrical Details (e.g. personalized deadlines)	1
Collaborative Group Guidance	1
Fast-Changing Domains	1
Formal Education	1
Previous Performance	1
Producing Automated Summaries/Overviews	1
Recommendation Systems	1
Structured Exercises	1
Time-Constraints on the Student	1

Table 11: The purposes for which adaptive learning systems are used (in descending order by the number of interviewees who said so).

#### **B2. Do you think that there are benefits in using an adaptive learning system? Do you think adaptivity in a learning system brings added value to the user?**

The adaptive analogue to question A8, asked the interviews to list the benefits of using an adaptive learning system. The results, summarized in Table 12 are quite different to those for question A8. The user-agnostic benefits of non-adaptive learning systems (e.g. communication, a centralized source of material and the re-usability of learning materials, etc.) are replaced by more user-centric benefits (e.g. efficiency with respect to the learner, tutor and author, user specific benefits, relevant learning material, etc.).

Efficient	11
User Specific	9
Relevant Learning Material	4
Personalized	3
Re-usability	3
Student Motivation	3
Avoids Information Overload	2
Automation	1
Flexible	1
Monitoring	1
Temporal and Spatial Relevance	1

Table 12: The benefits of adaptive learning systems (in descending order by the number of interviewees who said so).

### 3.4.1 Specific Features of Adaptivity

The following two sub-sections deal with the specific features of adaptivity (what we can adapt to) and the specific dimensions of adaptivity (what we can adapt). In both cases, we first asked the interviewees to list what a learning system could adapt to and what it could adapt in an open-ended question. We then provided them with a comprehensive list of features and dimensions as found in the adaptive hypermedia literature and asked them to rate each feature or dimension on a score of one to ten (one being unimportant and ten being very important). In the course of these questions we referred to the demo scenario on many occasions to help explain the features and dimensions to those unfamiliar with adaptivity. A comprehensive review of many of these features and dimensions can be found in [1], [2], [3], and [5].

#### **B3. To which characteristics of the user or environment would you expect a learning system to adapt? Which features should function as a source of adaptation?**

Table 13 summarizes the results. Prior knowledge, learning styles, preferences and learning goals were mentioned most often. We analyzed these results by using a frequency distribution over the three stakeholder groups for the most prominent categories (with mean greater than or equal to seven) (see Table 14, Table 15, Table 16 and Table 17). The important features remained the same when broken down by stakeholder group. The only slight discrepancy was with preferences; training providers tended to mention this feature more often than learners when compared with the three groups as a whole.

Prior Knowledge	19
Learning Styles	14
Preferences	9
Learning Goals	7
Ability	5
Platform	5
Interests	4
Background	3
Learning Speed and Time Available	3
Locale	3
Group Goal	2
Age	1
Gender	1
Group Achievement Level	1
Group Activity Level	1
Group Reputation	1
Hyperspace Experience	1
Modality	1
Quality of Service	1
Reputation within Group	1

Table 13: The characteristics of a user or environment to which a learning system could adapt to (in descending order by the number of interviewees who said so).

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	2	5	1	8
Listed	6	12	1	19
<b>Total</b>	8	17	2	27

Table 14: Prior knowledge by stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	3	8	2	13
Listed	5	9	0	14
<b>Total</b>	8	17	2	27

Table 15: Learning styles by stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	6	11	1	18
Listed	2	6	1	9
<b>Total</b>	8	17	2	27

Table 16: Preferences by stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	6	13	1	20
Listed	2	4	1	7
<b>Total</b>	8	17	2	27

Table 17: Learning goals by stakeholder group.

**B4. I will now list features that are reported in the literature to function as sources of adaptation, i.e. characteristics of the learner or environment that may be considered by a learning system for adapting the learning process to the individual learner. Please indicate your opinion on the importance of adaptation to each of these features on a scale from 1 to 10 (1 meaning not at all important and 10 meaning very important/critical)**

The listed features were:

- Learner goals/tasks - adapting to the current learning goal or current learning task;
- Learner knowledge and familiarity with the domain - adapting to prior knowledge and skills, performance level, current knowledge state;
- Student qualification - adapting to the learner's ability and quickness to acquire knowledge;
- Background - adapting to the learner's experience outside the subject;
- Experience in the hyperspace - adapting to the learner's ability to navigate in the internet;
- Personal preferences - adapting to preferences with respect to system usage tracked by the system or provided by the user, e.g. preferences in browsing hyperlinks;
- Learning or cognitive style - adapting to differing patterns of behaviour and preferences related to acquiring knowledge and the learning procedure, e.g. visual, auditory, kinaesthetic; inductive vs. deductive;
- Personality factors - adapting to the learner's personality style, i.e. stable features of a user on the personality dimension, e.g. introvert vs. extrovert;
- Interests - adapting to the learner's personal interests with respect to certain content or objects;
- Motivation - adapting to the motivational features of the learner, e.g. degree of achievement motivation;
- Language - adapting to the learner's mother tongue and foreign language skills;
- User role - adapting to a user's/learner's role in some situation/learning activity;
- Platform - adapting to the hardware, software, network bandwidth, etc., e.g. personal computer vs. mobile device; and
- User location - adapting to the user's current location.

Table 18 summarizes the results. All adaptation criteria were judged quite important; each criterion reached at least a mean importance of 5 (from a range of 0 to 10). The criteria judged to be the most important were

adaptation to learning goal/task (mean = 8.7, standard deviation = 1.82) and adaptation to learner knowledge (mean = 8.85, standard deviation = 1.19). A correlation analysis showed that the judgment of the learning goal/task is highly correlated with learner knowledge ( $r = 0.606$ ,  $p = 0.001$ ), and features medium correlations with student qualification, background, experience in hyperspace, language, and user role. The importance rating of learner knowledge was not correlated with any other criterion.

	<i>No.</i>	<i>Min.</i>	<i>Max.</i>	<i>Mean</i>	<i>S.D.</i>
<b>Learner Knowledge</b>	<b>26</b>	<b>6</b>	<b>10</b>	<b>8.85</b>	<b>1.190</b>
<b>Learning Goal/Task</b>	<b>27</b>	<b>4</b>	<b>10</b>	<b>8.70</b>	<b>1.815</b>
<b>Language</b>	<b>26</b>	<b>5</b>	<b>10</b>	<b>7.96</b>	<b>1.455</b>
Platform	26	3	10	7.77	1.583
Interests	27	2	10	7.22	2.136
Learning/Cognitive Style	27	2	10	7.19	2.403
Student Qualification	26	3	10	7.15	1.974
User Role	27	1	10	7.00	2.370
Motivation	27	1	10	6.96	2.682
Personal Preferences	27	1	10	6.26	2.474
User Location	27	1	10	6.04	2.361
Background	27	1	10	5.30	2.367
Personality Factors	27	1	8	5.07	2.368
Experience in Hyperspace	26	1	10	5.00	2.561

Table 18: Specific features of adaptivity as rated by the interviewees (ordered by mean ratings).

The least importantly judged aspects, although still characterized by a mean importance of about 5, i.e. medium importance, were background (mean = 5.3, standard deviation = 2.37) and experience in hyperspace (mean = 5.0, standard deviation = 2.56).

A statistical analysis was carried out in order to investigate whether there are significant differences in the importance ratings between the two main stakeholder groups (learners and training providers). Only for the adaptation criterion 'platform' a significant difference could be found, with learners judging the importance of this criterion higher (mean = 8.75, standard deviation = 0.37) than training providers (mean = 7.31, standard deviation = 0.41).

The adaptation criteria 'learner (or prior) knowledge' and 'learning goals' emerged from both questions (open question and importance rating) as the most prominent and important adaptation criteria. However, when analyzing the most frequent answer categories of adaptation criteria (from question B3) and their correlations with the corresponding importance ratings of the respective criterion (question B4), a significant correlation could only be found for learning style ( $r = 0.545$ ,  $p = 0.003$ ). This suggests that interviewees who named certain categories of adaptation criteria in question B3 did not necessarily judge them as highly important in the subsequent importance rating. This may be due to the fact, that imagining such criteria in an open-ended question was found difficult by interviewees - and when being confronted with the importance ratings they became aware of further criteria that they conceived even more important than those indicated previously.

### 3.4.2 Specific Dimensions of Adaptivity

We now proceed to the specific dimensions of adaptivity (what we can adapt). As with the specific features of adaptivity, we first asked the interviewees to list what a learning system could adapt in an open-ended question. We then provided them with a comprehensive list of dimensions as found in the adaptive hypermedia literature and asked them to rate each dimension on a score of one to ten (one being unimportant and ten being very important).

**B5. In which way would you expect adaptation in a learning system? What should be adapted and how should it be adapted?**

Table 19 summarizes the results. Structure of content, adaptive navigation (adaptation at the link-level) and adaptive presentation were mentioned most often. We analyzed these results by using a frequency distribution over the three stakeholder groups for the most prominent categories (mean greater than or equal to ten) (see Table 20, Table 21 and Table 22). It is evident, from each of the previous three tables, that the training providers were responsible for putting the structure of content, adaptive navigation and adaptive presentation at the top of Table 19. Perhaps, training providers are more aware of the details involved in authoring adaptive hypermedia than learners and are better able to explain what needs to be adapted.

Structure of Content	17
Navigation	11
Presentation	10
Agenda	3
Recommended Content	3
Activities	2
Exercises	2
Interface	2
Teaching/Learning Strategy	2
Feedback	1

Table 19: The dimensions that a learning system could adapt (in descending order by the number of interviewees who said so).

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	4	6	0	10
Listed	4	11	2	17
<b>Total</b>	8	17	2	27

Table 20: Structure of content by stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	7	8	1	16
Listed	1	9	1	11
<b>Total</b>	8	17	2	27

Table 21: Adaptive navigation by stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	6	10	1	17
Listed	2	7	1	10
<b>Total</b>	8	17	2	27

Table 22: Adaptive presentation by stakeholder group.

**B6. I will now list dimensions that can be the subject of adaptation, i.e. technologies that may be used for adapting the learning process to the individual learner. Please indicate your opinion on the importance of each of these adaptation dimensions on a scale from 1 to 10 (1 meaning not at all important and 10 meaning very important/critical)**

The items in bold are dimensions whereas the remaining items are specific techniques to implement adaptation based on these dimensions:

- **Adaptive content selection** - presenting information on a certain topic in different ways depending on learner characteristics.
  - Additional explanations - displaying additional information, illustrations, examples etc. matching the user's characteristics.
  - Prerequisite explanations - if prerequisites for a concept are not sufficiently known, the corresponding information is provided.
  - Comparative explanations - showing similarities between currently displayed concept and known ones.
  - Explanation variants - presenting the best fitting one of a set of different variants of a piece of information.
  - Sorting - fragments of information are sorted according to their relevance to the user.
- **Adaptive presentation** - adapt content of a hypermedia page to the user's characteristics.
  - Adaptive text presentation - adapting the textual content of a page to the user.
  - Adaptive multimedia presentation or adaptation of modality - selection of the types of media to present to the user is based on the characteristics of the user, e.g. video, image, text etc., or combination of them.
  - Customization of the interface - adapting background colour, text size, style, arrangement of items on the page etc. to learner preferences/characteristics.
- **Adaptive learning activity selection** - selecting a suitable learning activity for the learner based on his/her characteristics.
- **Adaptive navigation support** - help learners find their path through hyperspace by adapting link presentation to learner characteristics.
  - Direct guidance - providing sequential path through the system using the 'next best' strategy, e.g. guidance with a 'next' button.
  - Adaptive sorting - links of a document are sorted according to their assumed relevance, i.e. based on previous knowledge or similarity to current document.
  - Adaptive hiding - links are hidden or disabled if the system assumes that they are not relevant and/or distracting.
  - Link annotation - links are annotated by text, colouring, an icon, or dimming in order to give some extra information to the learner.
  - Map annotation or adaptation - used for graphical overviews and/or maps.
  - Adaptive link generation or adaptive resource recommendation - generating new links for a page, e.g. aiding users in decisions on matters related to personal taste through recommendations.
- **Adaptive problem solving support** - assisting the learner in problem solving.
  - Intelligent analysis of student solutions - providing the student with error feedback based on their final answers to educational problems.
  - Interactive problem solving support - providing the learner with intelligent help on each step of problem solving by giving a hint to executing the next step.
  - Example-based problem solving - helping learners to solve new problems by suggesting relevant successful problem solving cases from their earlier experience.

- **Adaptive assessment** - adaptive evaluation of learner's knowledge.
  - Adaptive testing - personalized explicit assessment in accordance with learner's performance, e.g. selecting problems depending on the learner's previous answers.
  - Adaptive questions - adapt appearance of questions, e.g. simple choice, multiple choice, fill-in-the-blank etc., and/or scoring to the learner's skills.
- **Adaptive service provision** - the system selects from various available modules and widgets those that are appropriate for the user.
- **Student model matching** - analyze and match student models.
  - Adaptive collaboration support - forming a matching group of students for different kinds of collaboration.
  - Intelligent class monitoring - comparing records of different students and identifying mismatches, e.g. students that accessed much less material than others.

Table 23 summarizes the results. As was the case for the features of adaptivity, all the adaptation dimensions have quite high ratings, with minimum averages between 5 and 6. The adaptation dimensions judged to be most important were adaptive content selection (mean = 8.33, standard deviation = 2.25) in general - and within this adaptation dimension, especially the techniques of additional explanations (mean = 8.37, standard deviation = 1.04) and prerequisite explanations (mean = 8.19, standard deviation = 1.98). Furthermore, adaptive learning activity selection (mean = 8.37, standard deviation = 2.02) and adaptive testing (mean = 8.22, standard deviation = 1.63) were considered highly important. The adaptation dimensions judged to be least important, but still featuring a medium mean importance score, were adaptive hiding (mean = 5.22, standard deviation = 2.55) and adaptive service provision (mean = 5.85, standard deviation = 2.71). Adaptive hiding seems to appear less popular and desirable in comparison to other techniques of adaptive navigation support, as the learner is deprived of information in this way, which was explicitly criticized by some interviewees. A statistical group comparison of the importance judgments of learners and training providers yielded no significant differences in the importance rating of any adaptation dimension.

	<i>No.</i>	<i>Min.</i>	<i>Max.</i>	<i>Mean</i>	<i>S.D.</i>
<b>Adaptive Learning Activity Selection</b>	27	1	10	8.37	2.022
<b>Adaptive Content Selection</b>	27	1	10	8.33	2.253
Additional Explanations	27	7	10	8.37	1.043
Prerequisite Explanations	27	1	10	8.19	1.981
Comparative Explanations	27	5	10	7.56	1.121
Explanation Variants	27	5	10	7.44	1.625
Sorting	27	1	10	7.26	2.177
<b>Adaptive Problem Solving Support</b>	27	5	10	7.93	1.299
Intelligent Analysis of Solutions	27	5	10	7.74	1.631
Example-Based Problem Solving	27	3	10	7.67	1.687
Interactive Problem Solving Support	27	3	10	7.37	1.822
<b>Adaptive Assessment</b>	27	1	10	7.89	2.082
Adaptive Testing	27	3	10	8.22	1.625
Adaptive Questions	27	1	10	6.52	2.376
<b>Student Model Matching</b>	27	1	10	7.56	1.888
Adaptive Collaboration Support	27	3	10	7.78	1.805
Intelligent Class Monitoring	27	6	10	7.70	0.953
<b>Adaptive Presentation</b>	27	1	10	7.52	2.242
Adaptive Multimedia Presentation	27	1	10	7.41	2.635
Adaptive Text Presentation	27	1	10	6.81	1.882
Customization of the Interface	27	1	10	6.63	2.041
<b>Adaptive Navigation Support</b>	27	1	10	7.33	2.760
Adaptive Link Generation	27	1	10	7.56	2.225
Adaptive Sorting	27	1	10	7.04	2.488
Adaptive Link Annotation	27	1	10	7.00	2.000
Map Annotation	27	1	10	6.96	2.244
Direct Guidance	27	1	10	6.70	2.267
Adaptive Hiding	27	1	10	5.22	2.547
<b>Adaptive Service Provision</b>	27	1	10	5.85	2.713

Table 23: Specific dimensions of adaptivity as rated by the interviewees (ordered by mean ratings of each category and then by sub-category).

The adaptive selection and structuring of content was the most prominent and important dimension of adaptation. However, when investigating the correlations between the adaptation dimensions commonly indicated by interviewees in question B5 and the importance ratings of the corresponding dimensions in question B6, no significant correlation could be found. This means, that there is no significant interrelation between the indication of a certain dimension of adaptation and the respective importance rating, which might stem from difficulties in freely listing adaptation dimensions (in question B5) and then being confronted with the predefined list in question B6.

### 3.4.3 Final Questions

Finally, the interview closed with two open-ended questions.

**B7. What functionality is essential for an adaptive learning system to be useful to you? In what way should it be presented to the user?**

Table 24 summarizes the results. There are really two parts to the question. The first asks for the essential functionalities. The functionalities listed most often were authoring advice, automated evaluation of user's characteristics, automated feedback, individualized adaptation and peer-to-peer communication and collaboration. Authoring advice and authoring functionality in particular, appear to be especially important to address the concerns raised by many of the interviews in response to the demo scenario with regards to the difficulty and complexity of authoring an adaptive course (see Section 3.2). The second part of the question asks whether the adaption process should be transparent or invisible to the user. An overwhelming majority indicated that this process should be transparent so that the user can 'scrutinize' the adaptation and feel in control. A further analysis by stakeholder group shows that the requirements for a transparent adaptation process as well as for authoring advice were stated mainly by training providers and the other (non-learner) stakeholders (see Table 25 and Table 26 for details).

Transparent Adaptation Process	7
Authoring Advice	6
Automated Evaluation of User's Characteristics	3
Automated Feedback	3
Individualized Adaptation	3
Peer-to-Peer Communication and Collaboration	3
Authoring Functionality	2
Help System	2
Recommendation System	2
Remote-Access	2
Support Students	2
Templates	2
Accessible to All Types of Users	1
Annotation of Material	1
Automated Grading	1
Content Management	1
Localized	1
Profit exceeds Effort	1
Reduce Cognitive Overload	1
Standards-Compliant	1

Table 24: Essential functionalities of an adaptive learning system (in descending order by the number of interviewees who said so).

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	8	12	0	20
Listed	0	5	2	7
<b>Total</b>	8	17	2	27

Table 25: Transparent adaptation process by stakeholder group.

	<i>Learner</i>	<i>Training Provider</i>	<i>Other</i>	<b>Total</b>
Not Listed	8	12	1	21
Listed	0	5	1	6
<b>Total</b>	8	17	2	27

Table 26: Authoring advice by stakeholder group.

### B8. What other application areas of adaptive learning systems can you imagine?

The last question of the interview was open-ended and asked the interviewees to list other application areas of adaptive learning systems outside of the higher education setting. The results (summarized in Table 27) list staff training and a system for teaching students with learning difficulties or disabilities at the top of the table. However, all of these application areas are interesting in and of themselves (e.g. recruitment systems that adapt to your qualifications and prior work experience and a system for learning networks of people that can adapt to your present network of friends/colleagues) regardless of how many interviewees mentioned them. In fact, adaptive simulations are being explored in the context of WP3 and WP4 of the GRAPPLE project.

Staff Training	9
Students with Learning Difficulties or Disabilities	3
Distance Learning	2
Knowledge Management	2
User Manuals	2
Adaptive Testing	1
Decision Support Systems	1
Delivery of Multimedia Content	1
Digital Newspapers	1
Games	1
Interactive Lessons	1
Life-Long Learning	1
Learning Networks (of People)	1
Practice Sessions	1
Provision of Technical Detail	1
Recommendation Systems	1
Recruitment Systems	1
Reference Systems	1
Simulations	1
User-Driven Systems	1

Table 27: Other application areas for adaptive learning systems (in descending order by the number of interviewees who said so).

## 4 Analysis of Interviews

The main objective of this deliverable is to identify the most relevant requirements from the user interviews that will form the basis for the construction of the GRAPPLE requirements. The views of our interviewees, comprising learners, training providers and others (researchers and developers) can be summarized as follows. They require an adaptive learning system that provides individualized teaching and learning. In particular, it should be capable of providing details of technical material that cannot be covered adequately in a class or lecture. They expect such a system to be efficient with respect to the learners, tutors and authors, by providing users with relevant learning material.

	No.	Min.	Max.	Mean	S.D.
<b>Learner Knowledge</b>	<b>26</b>	<b>6</b>	<b>10</b>	<b>8.85</b>	<b>1.190</b>
<b>Learning Goal/Task</b>	<b>27</b>	<b>4</b>	<b>10</b>	<b>8.70</b>	<b>1.815</b>
<b>Language</b>	<b>26</b>	<b>5</b>	<b>10</b>	<b>7.96</b>	<b>1.455</b>
Platform	26	3	10	7.77	1.583
Interests	27	2	10	7.22	2.136
Learning/Cognitive Style	27	2	10	7.19	2.403
Student Qualification	26	3	10	7.15	1.974
User Role	27	1	10	7.00	2.370
Motivation	27	1	10	6.96	2.682
Personal Preferences	27	1	10	6.26	2.474
User Location	27	1	10	6.04	2.361
Background	27	1	10	5.30	2.367
Personality Factors	27	1	8	5.07	2.368
Experience in Hyperspace	26	1	10	5.00	2.561

Table 18 and Table 23 provide a 'most-wanted' list of specific features and dimensions of adaptivity as ordered by their mean ratings. The most prominent features of adaptivity (with a mean rating greater than or equal to 7) in descending order as rated by the interviewees include adaptation to:

- Learner knowledge;
- Learning goal/task;
- Language;
- Platform;
- Interests;
- Learning/cognitive style;
- Student qualification; and
- User role.

On the other hand, the most prominent dimensions of adaptivity (with a mean rating greater than or equal to 7.5) in descending order as rated by the interviewees include:

- Adaptive learning activity selection;
- Adaptive content selection (especially additional explanations, prerequisite explanations and comparative explanations);
- Adaptive problem solving support (especially intelligent analysis of solutions and example-based problem solving);
- Student model matching (especially adaptive collaboration support and intelligent class monitoring); and

- Adaptive presentation.

The cut-off mean values we chose are arbitrary and the list of features/dimensions of adaptivity to be implemented in a system can be contracted or expanded as resources and time afford. However, their mean ratings can be seen to prioritize their need. For example, when implementing an adaptive learning system, the specific features of adaptivity you wish to support could be implemented in the following stages so as to please the majority of your users first:

- Learner knowledge, language, platform;
- Student qualification, user role, interests, learning/cognitive style;
- Motivation;
- Personal preferences, location; and
- Background, personality factors, and experience in hyperspace.

It is also worth re-iterating at this point some of the main responses to the demo scenario (see Section 3.2). The interview summaries were created and analyzed for this purpose. Both learners and the training providers appreciated the difficulty in and complexity of authoring an adaptive course. However, 'this environment has to be very easy to use so that the teacher can do it without the intervention of specialists'. An adaptive learning system requires appropriate authoring tools with as much authoring advice and help as possible. This was again reflected in the 'essential functionalities' question (B7) of the interview. In the context of the GRAPPLE project, WP3 will deliver the necessary authoring tools.

Through discussions with the stakeholders, two central ideas were often raised, namely, the added value of adaptive learning systems in higher education and the transparency of adaptation.

Higher education aims to create responsible students with independent critical thinking abilities. In their academic studies, they need to be responsible for their own learning and training. They need to identify what they need to learn and to choose the best path of doing so. In some respects, this is a contradiction to the goals of adaptive learning systems. Students are supposed to learn to learn.

The creation of adaptive learning content is time and work intensive and requires a good knowledge of each individual learner. These requirements are often difficult to fulfil in the context of higher education: the number teachers is finite and the provision of resources is often scarce.

In addition, adaptive learning systems can only cater to well explored and structured content. However, this is only one part of what a student needs to learn. They must also learn more abstract and complex competencies, e.g. social and relational skills, creative problem solving (where the 'correct' or 'best' solution is possibly unknown), independent critical thinking, etc.

Consequently, the GRAPPLE project should target those areas where adaptive systems can add value in the academic context. The interviewees propose some of these:

- The acquisition of basic knowledge;
- The acquisition of technical details that are too cumbersome to cover in lectures and classes, e.g. the details of the obscure and less-used libraries and functions of a programming language;
- Adaptive testing of basic knowledge; and
- Language skills.

Many interviewees insist that students should be made aware of the adaptation: they should be able to set adaptation parameters and always feel in control. There is also a potential conflict between a learner's preferred learning style and an optimal learning strategy. It appears to be a delicate trade-off between pleasing the learner and doing what's best for them from a pedagogical standpoint.

We can draw some more subjective conclusions from specific remarks and suggestions made by the interviewees. Several interviewees<sup>2</sup> consider distance learning to be a prime beneficiary of an adaptive learning system. In this setting, all forms of face-to-face contact are absent, and so it is deemed crucial that the learning content and its presentation are personalized to some degree. This can, in some way, make up for the 'human absence'.

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<sup>2</sup> 82291, 00321, 57016, 58018, 07011

Many considered the visualization of the various stages of learning and how they are adapted an interesting prospect<sup>3</sup>. One learner raised the question as to how he or she can know 'if they haven't missed anything important?' Learners need a visual map of where they are and where they are going with important milestones clearly marked. The training providers and tutors also require visualization of the learners' progress and the structure of the course as it currently stands. This is one of the concerns of WP4 – especially for the authoring stages.

An adaptive learning system should aim to motivate its users. For example, for some subjects that are traditionally considered 'boring', the material should be presented in such a way that encourages and stimulates<sup>4</sup> the learners. It should do this by appealing to their interests as specified in their user profiles, and adapt the content (e.g. specific examples) to these interests where possible. On a related note, the training providers and teachers must also be motivated and encouraged to use the system. The benefits must clearly outweigh the simple course web page and the non-adaptive LMS<sup>5</sup>. The typical training provider who 'uses the Blackboard learning system for logistics, FrontPage for authoring, wiki-software, and a blog' must see the benefits of an adaptive LMS and consider it worth switching. The training provider must first adopt the system and find it useful before the learners can. For this to work, the authoring tools must come with simple introductory documentation and perhaps 'wizards' that will get them started quickly. It must be possible for training providers to use and understand only part of the system in order to derive benefit from it. This will allow them to become gradually proficient in its features.

In order for an adaptive learning system to be 'training provider-friendly' it must cater for the bureaucracy and, on the other hand, diversity, that prevails in some environments<sup>6</sup>. For example, courses designed by a training provider may have to follow strict curricula that are laid down by the university; the authoring tools must cater for this requirement. Also, it is very important that training providers can import this information from other systems. If the university changes from system to system or if the training provider changes workplace, their previous work should not be lost.

Some observant interviewees pointed out the difference between 'global' and 'local' adaptivity<sup>7</sup> and the need for some formality. For example, content may be adapted locally depending of the learner's current knowledge, but also globally depending on the learner's learning style. It is a difficult and delicate task to correctly balance these different types of adaptation so that the output is neither pathological nor 'overly adapted'. In places, a formal definition language of sorts may be needed to avoid ambiguity – although only advanced users may require this. The GRAPPLE user interfaces, especially the authoring tools, may need both simple and advanced versions, themselves adaptable to the expertise of the author.

Reusable adaptive components<sup>8</sup>, like a grammar checker that adapts to a learner's previous mistakes (what grammatical structures does this user repeatedly misuse?), a task manager that adapts to a learners present workload/schedule and an adaptive recommendation component<sup>9</sup>, are deemed useful by the interviewees. It may be desirable to have an adaptive learning component employ some well-known metaphors, e.g. the book paradigm when organizing learning content<sup>10</sup>.

The user model need not be a black box (e.g. the permanent record of a 'school') used only by an adaptive learning system; it can be viewed in a more positive light as a learner's portfolio<sup>11</sup>. The learner should always be able to inspect its contents to some degree. The system should be able to point out weakness between what a learner thinks he or she knows (perhaps through voluntary questionnaires) and what they appear to know from tests and exercises. It can help them identify their strengths and weaknesses. It could also point out the discrepancies (if any) between an optimal learning path and a preferred learning path as indicated by

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<sup>3</sup> 81023, 74031, 64002

<sup>4</sup> 82002, 57016, 84001, 82004

<sup>5</sup> 60063, 58018, 73072

<sup>6</sup> 06210, 77132, 80037

<sup>7</sup> 79017, 64044

<sup>8</sup> 74031, 08212, 64002, 67031

<sup>9</sup> 80037, 82291, 58018

<sup>10</sup> 00623

<sup>11</sup> 64042, 80037, 84001, 64002, 81023, 82004

the learner. To a lesser degree, it may be used to match learners with their peers who are strong in areas they are weak in and vice versa.

## 5 Conclusions

A key task of the GRAPPLE project has been completed in this deliverable, with the drawing up of requirements as viewed by learners and training providers in the academic setting. The foregoing interviews and their analysis in the previous section will form a basis for the construction of the GRAPPLE requirements (WP8, WP9 and WP10). This will ensure target-oriented work from the outset. This appears to be the first study where the requirements for an adaptive learning system as viewed by the intended users (learners, tutors and authors) were gathered at the beginning of the project instead of introducing users at later stages.

In light of these results, other WPs within the GRAPPLE project will also benefit. The specifications for the domain and conceptual adaptation models (WP3) will need to cater for the features and dimensions of adaptivity sought by users. In particular, the extension of these specifications to simulated and virtual reality environments (WP3) and the development of authoring tools for these varied environments (WP3 and WP4) can prioritize their feature set according to the aggregated interview results. WP4 will also provide appropriate visualizations to make these structures more understandable. This should satisfy the majority of users and should become evident during the evaluation in the academic setting (WP9).

It is suggested that one indicator of the success of the GRAPPLE project will be its provision of the 'most-wanted' features and dimensions of adaptivity as specified by the stakeholders. Deliverable D10.1 will complement these with the 'most-wanted' features from the corporate or industrial setting. These features and dimensions of adaptivity will be provided as services that will be incorporated into Open Source and commercial LMSs (WP7) whose support for such adaptation has traditionally been weak [4]. Many more 'subjective' suggestions, as were raised by the individual interviewees, were outlined in the previous section.

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## 7 Annexes

### A. Requirements Analysis Methodology

#### B. Interview Summaries

### A Requirements Analysis Methodology

This annex includes the Requirements Methodology for implementation and analysis (internal documents) developed in WP8 (UniGraz). This methodology actually constitutes a part of the evaluation framework and will be reported in the respective deliverables.

Annexes A.1 and A.2 contain content from the internal deliverable *Requirements Analysis Methodology* developed in the context of WP8 Evaluation Framework (UniGraz).

Annex A.3 contains content from the internal deliverable *Interview Content Data Analysis* developed in the context of WP8 Evaluation Framework (UniGraz).

#### A.1 Methodology and Guidelines for Requirements Analysis

##### Summary

In the following, the methodology elaborated in GRAPPLE for the purpose of eliciting and analysing user requirements with respect to personalisation and adaptivity in learning systems is outlined. The methodology constitutes the first part of the evaluation framework developed in WP8. It consists of a general introduction to the field of requirements engineering (section 1) and an elaboration on the topic of requirements elicitation in the context of the GRAPPLE project (section 2). The development of an interview guide for semi-structured stakeholder interviews is outlined (section 3) and guidelines for the requirements elicitation process are provided (section 4). The interview guide is designed to function at the same time as a protocol for note taking during the interviews (section 5). The interviews will target academic and corporate users, respectively, and the results on the gathered personalisation and adaptation needs and user requirements towards integrated adaptive learning services will be reported in the respective deliverables D9.1 and D10.1, for university settings and, respectively, for industry settings.

##### 1. Introduction

The primary measure of success of a software system is the degree to which it meets the purpose for which it was intended" (Nuseibeh & Easterbrook, 2000, p. 35). This means, that a critical prerequisite for a successful development of software and technology is the fulfilment of user requirements. Even though GRAPPLE largely builds upon existing software for developing a generic responsive adaptive learning environment, a thorough **analysis of user requirements** is important for the project in order to provide a sound input and basis for research and development and to ensure that work is targeted towards the right direction from beginning of the project. This is, why a systematic collection of personalisation and adaptation needs of academic and corporate users is to be carried out in the first phase of the project. These needs will be identified through a close cooperation with stakeholders and based on a sensitive and well-founded methodology for eliciting and analysing requirements. The methodology for requirements analysis is developed as a first step and part of the evaluation framework.

**Requirements are descriptions of the functionalities and services** to be offered by a software or system. The requirements reflect the needs of users towards a system that can support them in carrying out different tasks (Sommerville, 2007). Software requirements engineering, or purely '**requirements engineering**' is dedicated to detecting, analysing, documenting, and checking such requirements, i.e. it constitutes the process of **investigating the purpose of a piece of software** (Abran, Moore, Bourque, & Dupuis, 2004; Nuseibeh & Easterbrook, 2000).

In general, two different types or rather levels of requirements can be distinguished (Sommerville, 2007), user requirements and system requirements. **User requirements** constitute requirements on a **more abstract level** and are statements and descriptions in **natural language**, documenting the functionalities

and serviced that the software is expected to perform and the conditions of its use. **System requirements**, though, represent requirements on a more **detailed level**, defining the **functionalities, services, and constraints** in a particularised way. Thus, system requirements are generally based on user requirements and elaborate and extend them further towards their technical implementation. For the purpose of GRAPPLE, the focus of interest is on user requirements, i.e. more generally formulated needs, expectations, and opinions towards adaptation and personalisation – which will be documented separately for academic and corporate users in the D9.1 and D10.1 deliverables and which will direct research and development work.

The process of requirements engineering is also called requirements analysis and involves activities of eliciting, representing, analysing, and recording requirements. In general, however, there is no widely accepted terminology, rather it is sometimes referred to loosely by terms as requirements gathering, requirements capture, or requirements specification. For eliciting requirements a range of methods exist, such as interviews, questionnaires, focus groups, prototyping, use cases etc (e.g. Abran et al. 2004; Goguen & Linde, 1993). The process of eliciting user requirements needs to be done carefully and sensitively as it is complicated by a number of difficulties. Users often have difficulties to articulate and describe their needs, or are even not aware of them; goals may vary or conflict over time or depending on the task that is to be accomplished etc. (Nusbeibeh & Easterbrook, 2000; Goguen & Linde, 1993). Requirements analysis in the narrow sense is concerned with detecting and resolving conflicts between requirements and discovering the bounds of the software and how it needs to interact with the environment (Abran et al., 2004). Once analysed, requirements need to be documented and translated into functional requirements and specifications (e.g. requirements documents, process specifications) such that they can be systematically taken into account and implemented in the development process. The validation of requirements aims at checking whether the requirements actually define the software desired by the stakeholders. The fulfilment of the defined requirements is then to be addressed in evaluation. The requirements process will most probably be of an iterative nature, which involves revisiting and updating requirements during the development cycles of a software system (Sommerville, 2007).

In general, in requirements engineering the viewpoints of different types of stakeholders need to be identified, represented, and managed (Abran et al., 2004). Therefore, requirements elicitation should ideally involve different stakeholders, in order to capture their different views and needs, to analyse differences between them and integrate them to a comprehensive set of requirements.

## 2. Requirements Elicitation in GRAPPLE

Requirements elicitation involves activities through which requirements are discovered by **consulting the stakeholders** of the system or software to be developed (Herlea, Jonker, Treur, & Wijngaards, 2002). It constitutes the first step in establishing an understanding of the problem or task the software is required to solve or assist. This process is often variously termed and also known as 'requirements capture', 'requirements discovery', and 'requirements acquisition' (Abran et al., 2004).

A range of elicitation techniques is available for carrying out this process (e.g. Goguen & Linde, 1993). Among them are for instance

- interviews (dialogue with stakeholders to understand their needs)
- focus groups (moderated meeting with a group of people representing different stakeholder groups)
- questionnaires (written survey for gathering requirements information)
- protocol analysis (asking a subject to think aloud while performing a task)
- prototypes (mock-up of an application) and
- use cases (scenarios conveying how the system should interact with the end user or another system)

The selection of techniques for requirements elicitation depends on the time and resources available, contextual and overall conditions and purpose of the requirements engineering and the particular application domain.

The requirements elicitation for GRAPPLE will be carried out through **stakeholder interviews**, which are actually a 'traditional' method for gathering requirements and part of most requirements analyses (Abran et al., 2004; Sommerville, 2007). Interviews are well-suited for establishing a comprehensive understanding of the stakeholders' opinion and needs, the task that they need to accomplish, and probably their experiences and problems with existing software (Sommerville, 2007). There are different approaches conceivable for carrying out stakeholder interviews, corresponding to amount of structure and constraints implied in the interview technique. On principle, three different models of interviews exist – the unstructured, the semi-

structured, and the structured interview (Wilkinson & Birmingham, 2003). In practice, interviews with stakeholders often constitute a combination of those.

- A **structured (or standardised) interview** means that the same questions are asked of all respondents, with the same wording and in the same sequence (Corbetta, 2003). The questions in a structured interview very often provide a fixed range of answers, i.e. are closed ended. Thus, this sort of interview is very restrictive as it makes sure that questions are asked in the same way for all interviewees and interviewers. In this way, the data gathered is easier to analyse, code and compare. However, this approach bears the risk of losing important and unanticipated information (Harvey, 1998).
- A **semi-structured interview** provides more flexibility, while nevertheless ensuring to keep to a leitmotif. Although questions are predetermined, there is sufficient flexibility that allows shaping the flow of information (Wilkinson & Birmingham, 2003). This type of interview is characterised by an interview guide that provides a list of key questions or topics to be covered. In general, the wording of the questions and often also their order is left to the interviewer's discretion. Thus, in a semi-structured or guided interview only a guide for the conversation is provided that ensures that the interaction is kept focused, covering same ground, but allowing individual experience to emerge. There is room to ask for clarification if questions or answers are not clear, to probe for further information and to include or elicit issues that were initially not considered. This sort of interview is particularly suitable for qualitative analysis, for example for exploration purposes (Bhamani Kajornboon, 2005).
- An **unstructured interview** is pure informal and conversational and allows full freedom in carrying out the interview and in responding without the need to follow an interview guide. However, this technique requires a lot of time to get systematic information and can prove extremely difficult to analyse (Harvey, 1998; Wilkinson & Birmingham, 2003)

In sum, interviews – especially semi- or unstructured ones provide an effective way for giving insight into people's perception, thinking, and opinion, because of the ability of an interviewer to ask follow ups, to probe questions, to clarify or expand on an idea (Baty, 2007).

For the purpose of GRAPPLE a semi-structured interview has been identified as an appropriate technique for requirements elicitation for several purposes. The interviews will be carried out by different project partners at different places and times. A semi-structured interview, and thus the use of an interview guide ensure that the interviews carried out by different project partners have a common ground and overall structure and thus, are comparable. On the other hand, it is important to allow that the interview is conducted in an explorative way in order to make possible gathering of information that would not have been anticipated. Although the current state of the art on adaptivity in education should be taken into account and be referred to, personalisation and adaptation needs should be elicited and analysed in an unrestricted manner which allows capturing aspects of adaptivity that are not evident and would not have been anticipated. For requirements elicitation regarding personalisation and adaptation in GRAPPLE this means, aside from presenting interviewees with questions referring to current state of the art in adaptivity by offering them a restricted set of possible responses, there should be left open enough space for open-ended questions that allow interviewees to answer to a posed question as he/she wishes and that offer the possibility of probing for more detail (Goguen & Linde, 1993).

Weibelzahl, Jedlitschka, and Ayari (2006) utilised scenarios in combination with structured interviews for the elicitation of requirements of an adaptive system. **Scenarios** were used as a **supporting tool for the interviews** in order to help the interviewees to imagine the concrete situation of applying the adaptive system. By using different scenarios emphasising different roles and letting interviewees answer the questions from the perspective of these different roles, the authors assumed to be able to uncover differences in user requirements of the different roles or stakeholders. Instead of letting one person judge the requirements from different perspectives (which will probably be quite difficult), however, it seems more practical, realistic, and valid to actually involve representatives of different stakeholder groups or owning different roles. The use of different scenarios would then be restricted to providing perspectives of different situations and use cases. The general idea of using scenarios for enhancing the interviewees' understanding and contextualising the questioning procedure seems very practical and can definitely contribute to gather useful information. Therefore, scenarios will be utilised as supporting tools for carrying out the stakeholder interviews for requirements analysis in GRAPPLE. The scenarios will assist in ensuring the interviewees understanding of adaptivity and will set the scope for the interview procedure.

### 3. A Semi-Structured Interview Guide for GRAPPLE Requirements Elicitation

An interview guide for structured interviews has been established in order to gather information regarding current usage of adaptive systems and needs and opinions with respect to personalisation and adaptation in learning systems. The main aim is to gather explorative data in order to identify aspects and kinds of adaptivity and adaptive features that are especially desired, expected, and accepted by users. To this end, currently used technologies of adaptation and personalisation as documented in the literature had to be taken into account. An exploration and review of current state of the art in adaptivity research has been done in order to ensure that relevant aspects of adaptivity are captured by the interview guide (e.g. Brusilovsky 1997, 1999, 2001, 2003, 2004; Hauger & Köck, 2007; Kravcik, 2005; Weber, 1999). Mainly, this refers to the questions of 'to what to adapt?' (adaptation criteria) and 'how (or what) to adapt?' (adaptation technologies or dimensions). Furthermore, the literature research provided a basis for creating a short introduction, or respectively, definition of adaptivity – which is envisaged to be presented to the interviewee at the beginning of the interview. This will define the scope and context of the interview and ensure the interviewee's basic understanding of the concept of adaptivity.

As a further instrument for enhancing interviewees' understanding of adaptivity, the scenarios that have been developed in WP9 and WP10 for university and industrial settings, respectively, will be presented to the interviewees. This will foster an appropriate contextualisation of the conversation and help the interviewee to imagine the concrete tasks that are to be covered by the use of an adaptive learning system. Depending on the setting (i.e. WP) in which the interview is carried out the respective scenario documents will be provided to the interviewees before the interviews by asking the interviewees to read them as a preparation for the interview.

In the sequel, the structure of the interview guide is outlined. In general, the interview guide defines the interview structure and documents the issues that are to be covered during the interview. Please note, that this is to specify and fix the topics, in this way making sure that all interviews are carried out on the same scope, while the wording of the questions is completely left to the interviewer's discretion (besides, for some partners it will be necessary to adapt the interview guide to their native language). For further information see also the following section "Guidelines for GRAPPLE Requirements Elicitation: An Interview Manual".

The interview consists of two main phases, an instruction/information part – in which the scope of the interview is set and background information is provided to the interviewee. The second part constitutes the actual interview.

#### **Instruction/Information Part:**

After mutual introduction of interviewer and interviewee, basic information about the interview (date, place, interviewer, interviewee code, stakeholder group, job role) is documented. It is clearly stated that the information collected will be treated confidentially and anonymously. Then, an overview over the interview procedure and an instruction to the question and answering process is given. Subsequently, the purpose and objective of the interview is presented. To ensure that the interviewee is aware of the concept of adaptivity, a short introduction and definition is given. After that, the scenarios (which have been provided to and read by the interviewee beforehand) are shortly recapitulated and eventual questions are clarified.

#### **Interview Part:**

In the first stage of questioning, the current usage with respect to adaptive learning systems is identified (questions A1-A8). This can be used in order to categorise interviewees in groups of experienced and less-experienced/inexperienced users and might provide interesting information for further analysis of gathered requirements, e.g. differences depending on the actual experience with adaptive systems. The main part of the questioning procedure then concentrates on the opinion and requirements regarding adaptivity (questions B1-B8). Question B1 aims at eliciting reasons and tasks for using an adaptive learning system. Question B2 aims at identifying benefits of an adaptive learning system for the improvement of learning and teaching. Question B3-B6 aim at explicitly eliciting adaptation needs and preferences. In order to get unbiased but comparable answers at the same time the elicitation of adaptivity needs/preferences was split in two parts. First, in questions B3 and B5 it is asked openly, without guidance, for adaptation criteria and, respectively, adaptation technologies that should be provided by a learning system. These questions are open-ended in order to not neglect relevant aspects a priori. In a second step, two standardised (closed) questions are presented to the interviewee in B4 and B6. On these questions the interviewee has to rate the importance for each item of given lists of adaptation criteria and, respectively, technologies as they can be found in the current literature. With respect to B6, broad adaptation dimensions (e.g. adaptive navigation support) as well as specific techniques within these dimensions (e.g. adaptive annotation) are listed and to be judged. This also helps to make kind of a consistency check of the interviewee's responses, as for a broad dimension being judged as very important, there should be at least one kind of specific technique that

also has great subjective importance and vice versa, if the specific techniques within a dimension are judged to be highly important, then also the subsuming technology should be regarded as important. Question B7 tries to elicit which functionalities are deemed essential to an adaptive learning system. Question B8 is not intended to elicit new requirements, but to confirm the relevance of the scenarios and to identify new/other application areas for adaptive learning systems.

#### 4. Guidelines for GRAPPLE Requirements Elicitation: An Interview Manual

This **manual** has been developed to accomplish a **successful interview process**. Some of the information given in the sequel might seem basic and self-evident, still it is useful to make those things aware by reading through the manual – such that there is a common understanding of what is important before, during, and after the interviews.

The **main objective of the interviews** to be carried out is to gather information on **opinion, expectation, and needs towards personalisation and adaptation** from academic and industrial stakeholders, which will subsequently be analysed and documented in the respective requirements deliverables of WP9 and WP10. These requirements documentations and specifications constitute important information for guiding the work on adaptivity and will provide useful input for other WPs to direct their work towards the expectations and needs of prospective and potential stakeholders. It is important for the data collection that this main aim is kept in mind during the interview process.

##### Interviewers:

**All partners** involved in **WP9** or, respectively, **WP10** are expected to contribute to the requirements elicitation and analysis by carrying out stakeholder interviews. As rich interview data with relevant information is essential to be gathered during the interviews, we recommend to value quality more than quantity when carrying out the interviews. During the interviews as much rich and useful information as possible should be gathered. The data collected during these interviews will be analysed and summarised by the individual partners according to the guidelines provided for content analysis in a further version of this methodology. The (preliminary) results of the individual partners will be collected and consolidated by the WP/task-leaders to feed into the deliverables D9.1 and D10.1.

##### Interviewees (Stakeholder Groups):

For carrying out the interviews stakeholders<sup>12</sup> need to be selected to talk to. Interviewees should be contacted and presented with GRAPPLE project information and informed about the purpose of the interview (Questions will not be handed out before the interviews). In order to analyse, compare, and integrate needs and requirements from different perspectives, two different stakeholder groups have been selected for each of the two settings. The groups of stakeholders selected for the interviews differ for academic and industrial settings, but are assumed to constitute representative and relevant stakeholders in the respective settings whose opinions need to be paid attention to. The involvement of different stakeholder groups allows to capture views from different perspectives and thus a more comprehensive way of investigating users' needs and to uncover possible divergences and contradictions among requirements of different stakeholders. In general, it would be preferable to recruit persons for the interviews that will be available and willing to take part also in eventual follow up analyses for revisiting and updating requirements.

Stakeholder groups to be interviewed in **university settings** are **learners (i.e. students)** and training providers, which will mostly be represented by **teachers (i.e. lecturers**; which are most probably at the same time course authors). In the context of university, these two groups seem to be the prevalent stakeholder groups – normally a lecturer will take an existing learning system and put his/her course material in it for his/her lecture to students. Other roles that can be subsumed under the label training providers and which are therefore suitable to be interviewed are administrators and publishers in a university context.

In **industry settings** it is difficult to capture the same stakeholder groups as in university. Most probably, there will not be single teachers or course authors, but rather institutions that provide e-learning facilities and courses. Therefore, (and this was also indicated by ICM during the kick-off meeting) learning/training providers seem to be a more probable target audience for stakeholder interviews (including also authors, human resource managers, data protection officers, administrators, and publishers). Furthermore, of course, prospective learners are an important audience to be addressed – in this case, workers that might need

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<sup>12</sup> As a reminder, at the kick-off meeting the following relevant groups of stakeholders were identified: teachers, students, publishers, pedagogical advisors – media centre's, course authors, training managers/providers, LMS administrators, scientists and researchers (further classification: experienced, un-/less experienced)

some further education or training. Stakeholder groups to be interviewed in industry settings are therefore **learners (i.e. workers in need of further education or training)** and **training providers**.

**Number of Interviews:**

A reasonable and fair rationale for allocating the number of interviews to be carried out by each partner was tried to be established. As it was agreed that all partners involved in WP9 and WP10, respectively, will do several interviews, it is most suitable to do the distribution of requested interviews **corresponding to each partner's involvement (i.e. person months) in the respective work package**. For an overview on the number of interviews suggested to be carried out depending on the WP-related involvement/effort, see the following table:

Person months (PM) in WP	Number of interviews for respective WP
3 PM	2
6 PM	3
10 or more PM	5

Each partner is requested to carry out the **number of interviews** as calculated according to this rationale and indicated in the **table** below, and involving the specified **number of stakeholders** from each **stakeholder group**.

Partner	WP9 University Setting		WP10 Industry Setting	
	Number of Interviews	University Stakeholders	Number of Interviews	Industry Stakeholders
TUe	2	1 learner (student) 1 teacher (lecturer)	2	1 learner (workers) 1 training provider
OUNL	5	3 learners (student) 2 teachers (lecturer)		
LUH			3	2 learners (workers) 1 training provider
VUB	2	1 learner (student) 1 teacher (lecturer)		
Warwick	2	1 learner (student) 1 teacher (lecturer)		
USI	2	1 learner (student) 1 teacher (lecturer)		
UniGraz	3	2 learners (student) 1 teacher (course author)	2	1 learner (worker) 1 training provider
DFKI			3	2 learner (worker) 1 training providers
TCD	3	1 learner (student) 2 teachers (lecturer)	2	1 learner (worker) 1 training provider
UCL	3	1 learners (student) 2 teacher (lecturer)		
UCAM	2	1 learner (student) 1 teacher (lecturer)		
GILABS			5	2 learners (workers) 3 training providers
IMC			5	2 learners (workers) 3 training providers
ATOS			5	2 learners (workers) 3 training providers
<b>Sum</b>	24	12 learners (students) 12 teachers (lecturers)	27	13 learners (workers) 14 training providers

The resulting total number of interviews is a bit higher for the industry setting, which is well justifiable and expectable given the greater amount of person months foreseen for WP10.

**Scenarios:**

The scenarios created for industry and university are used as supporting tools for the interview. Depending on the context of the interviews (**business or academic setting**) the **respective scenario(s)** are to be

**provided to the interviewees.** Make sure that the interviewee receives the scenarios a **one week before** the planned interview date (by handing it out or sending it via email) together with the kind **request to read** them in the time left until the interview. Stress the importance of actually reading them, as this will serve as a good preparation and basis for the conversation. Point to the **task of judging the scenarios' relevance** for the interviewee's respective stakeholder group. Let the interviewee also know in advance about the aim of the interview – obtaining their opinions and needs with respect to adaptive learning systems. In this way, the interviewees can feel more prepared and comfortable and responses in the interview might be more directed. During the interview, the scenarios will be recapitulated and eventually arisen questions are clarified, and the relevance judgements for the individual scenarios will be gone through and documented.

**Interview duration:**

For **each interview 45 minutes** should be set aside. This time frame should also be communicated to the interviewee. This will ensure to have enough time to talk about all the topics foreseen. If you are planning to conduct several interviews subsequently, it is recommended to leave 30 minutes time between the interviews. This provides the opportunity to make additional notes that probably could not be captured during the interview and to clear the mind before the next interview starts.

**Language:**

The interview guide provides an outline of the questions and themes of the conversation. Most probably, the actual interviews will be carried out in the **native language** of the respective project partner which requires adapting **the interview procedure** accordingly (whether this is done by explicitly adapting and translating the interview guide/protocol or by simply using native language during the interview is left over to the partner/interviewer). This is no problem, as the interviews are carried out as semi-structured interviews, which allows a flexible questioning procedure rather than a strictly standardised one.

**Concept of adaptivity:**

Interviewees, unless experienced in the use of learning software, will probably be not explicitly aware of the concept of adaptivity. As a prerequisite and **basis for the conversation** it is necessary that the interviewee is generally informed about the concept of adaptivity. This means, the **general idea of adaptivity** needs to be conveyed, in order to be able to subsequently elicit the interviewee's understanding and opinion on it. It needs to be guaranteed that questions posed are understood in order to establish a fruitful conversation that delivers important and applicable information. Aside from a **short general introduction and explanation of adaptivity**, especially the **scenarios** created for academic and industrial settings and provided beforehand will help the interviewees to imagine adaptivity and the concrete tasks covered by the use of an adaptive learning system.

**Questions and wording:**

The interview guide indicates the structure and questions that are to be covered by the interviews and is used as a common base for conversation. The guide has been developed to feature a reasonable sequence of questions; thus please **stick to the interview structure and sequence** provided. Although suggested formulations for the questions are provided, the **exact wording** of questions during the interview is **left over to the discretion of the interviewer**. This is also the case for the instructions, the explanation of the interview purpose and adaptivity – regard the indicated formulations as suggestive but not obligatory. **Alternative wordings, further explanations or examples** may be used in any case. In general, try to be neutral and non-suggestive, bear in mind that we aim at gathering stakeholders' personal opinions and needs. For questions B4 and B6 please keep to the provided list and ensure that all the issues covered are worked through and rated. In case of question B6 provide the explanations indicated in the table or alternative/additional ones for better understanding of each item.

**Interview procedure:**

The stakeholder interviews are foreseen to be carried out **face-to-face** and **one-to-one**. Try to establish a **pleasant and relaxed atmosphere** for the conversation. Despite keeping to the interview structure, try to be **flexible and respond to the interviewee**. Ensure that the interviewee understands the questions correctly, guard against misunderstandings. Answer requests for further explanations, give hints and examples (e.g. refer to scenarios). Show interest and probe for details. Encourage the interviewee to talk while at the same time keeping him/her on track. Be patient and give the interviewee time to think. Before finishing the interview make sure that all relevant questions have been dealt with and answered.

**Interview recording:**

To **document the conversation** you should make **notes**. The interview guide is designed to function also as **interview protocol**, leaving space for taking notes and documenting the interviewee's answers. Prepare

additional sheets of paper for further notes that can be attached, in case that there is not enough space on the protocol. It is helpful to use a digital recorder during the interview – as it allows going back and listening if something has been missed in the notes or if something is unclear. If you record the interview, ask the interviewee for permission. If he/she feels uncomfortable with being recorded you will have to rely on your notes. When the interview is recorded, it does not need to be transcribed completely. Rather it can be used to control the accuracy of the notes and to complement or if necessary correct them. If only notes are taken please ensure to keep as precise and accurate notes of relevant information as possible. if necessary, ask an interviewee to wait while you make a note; time taken for taking notes can be useful for giving breathing space during the conversation. However, take care, that the conversation keeps going. For a comprehensive and informative picture of the conversation make additional notes immediately after the interview, if necessary.

**Interview summary:**

Type out your notes after the interview (the sooner, the better) to a summary document that provides a **comprehensive overview of the interview**. The summary should be in English and should be a condensed version of the conversation's content and reflect relevant and rich information. It should be rather short and does not need to reflect all details of the conversation (details will actually be documented in the interview data sheets [templates to be provided soon]). Sometimes direct quotes reflect the interviewee's perspective best, but usually you may use your own words. The interview summary serves for getting a quick overview of the conversation in a rather narrative form. The collected interview summaries will most probably be annexed to the D9.1 and D10.1 deliverables.

**Interview data input and analysis:**

The notes of the interview documented in the interview protocol will be collected and documented in interview data sheets, for which templates will be provided as a further part of the requirements analysis methodology. Recording the interview data in those data sheets should be done as soon as possible after the interview. The qualitative data collected during the interviews will be further analysed through **content analysis**. This will be done **by the individual partners** that carried out the interviews according to the guidelines that will be provided in a further version of the requirements analysis methodology. The interview results of each partner will then be consolidated to a comprehensive documentation of users' personalisation and adaptation needs for the requirements deliverables D9.1 and D10.1.

## **A.2 Interview Guide and Protocol**

### **1. Interview Guide**

On the following pages you can find the interview guide as developed and to be used for the stakeholder interviews in the scope of requirements elicitation and analysis in academic and university settings. The interview guide is designed to serve as an interview protocol, i.e. for taking notes on the conversational content during the interviews. For the convenience of the interviewer the interview guide is additionally also provided in a separate document - for ease of printing and handling. Please use this separate document for printing and copying in interview preparation. For further information on the interview procedure please refer to Annex A.1, especially section 4 outlining the guidelines for the requirements elicitation.

# GRAPPLE

## Requirements Analysis Methodology: Interview Guide and Protocol

*For detailed information on the interview procedure and use of the interview guide please refer to the interview manual provided in the Requirements Analysis Methodology document!*  
*Formulations for instruction, purpose of the interview, and the adaptivity concept are suggestive, alternative wordings may be used. The same applies for wordings of questions. If necessary, please adapt and translate to your native language. Instructions or remarks on questions for the interviewer are indicated in parentheses and italic.*

### **1) INSTRUCTION/INFORMATION PART**

#### **Introduction**

##### **Basic Information**

Interview setting:	<input type="checkbox"/> university (WP9) <input type="checkbox"/> industry (WP10)
Partner (short name):	
Date:	
Place:	
Interviewer:	
Interviewee code: (multi-digit number consisting of year of birth (two digits) and house-number)	
Stakeholder group:	<input type="checkbox"/> learner <input type="checkbox"/> training provider (incl. teachers, lecturers, authors, HR-managers, administrators etc.) <input type="checkbox"/> other: _____
Job role or function (with respect to stakeholder group)	

Additional Notes:

#### **Instruction**

- confidential and anonymous
  - Your answers will be used for research work within the GRAPPLE project only. The information collected from this interview will be kept confidentially and your data will be treated anonymously. We are only keeping a unique code from you for comparison and linking purposes in case of repeated interviews.
- opinion matters

- Please note, that we are interested in your opinion and preferences – there are no right or wrong answers.
- outline
  - First, I will inform you about the purpose of this interview and give you some background information relevant for you for answering the questions. After that, we will go through some questions. Most of them you can answer openly, for a few you will be asked to indicate priorities or rankings. In any case, there is always the possibility of mutually clarifying issues, asking further questions or probing for details.

**Purpose of this interview**

- presentation of the scope and purpose of the interview
  - This interview is carried out in the scope of the GRAPPLE project, a project funded by the European Commission that aims in developing a learning system that supports lifelong learning by means of personalisation and adaptation to the learners’ needs and characteristics. Currently, we are in the phase of identifying and analyzing the needs and requirements that stakeholders have with respect to personalisation and adaptation. This will help us to ensure that the work carried out within GRAPPLE is aligned and directed to what prospective users expect and need. Therefore, the subject of this interview is your use of and expectation towards learning and educational systems. In particular, we are interested in getting your opinion on adaptive learning systems and features of adaptivity, like adaptation to preferences, characteristics, knowledge or environment etc. The purpose of this interview is to gather information which aspects of adaptation and personalisation are desired and needed. Please try to answer the questions from your point of view as a stakeholder. Of course, we are also interested in issues that you can imagine to be especially relevant for other stakeholder groups. Please note again that the aim of this conversation is to talk about your personal opinion on adaptive learning systems; and not to convince you about the benefits of such adaptive systems or features.

**Adaptivity and Scenarios**

- introduction of the basic concept and idea of adaptivity (demonstration of adaptive system or video presentation)
  - A learning system might be used by learners differing in their goals, learning styles, preferences, knowledge, and background. Based on these differing characteristics, they may be interested in different pieces of information presented by a learning system and may use different links for navigation. An adaptive learning system realises an alternative to traditional “one-size-fits-all” approaches in education. An adaptive learning system builds a model of the goals, preferences, and knowledge of each individual learner, and uses this model throughout the interaction with the user, in order to adapt to the needs of that learner – for example, a student will be given a presentation that is adapted specifically to his or her knowledge of the subject. An adaptive learning systems adapts the information and links being presented to the given user and/or assists the user in navigation (e.g. by limiting browsing space, suggesting the most relevant links to follow, or providing adaptive comments to visible links). Furthermore, different users may also have different environments and conditions for learning, e.g. differing hardware, platforms or devices. An adaptive system may also adapt to the learning environment and situation itself, e.g. to the platform and hardware used, or learning location. To sum up, an adaptive learning system is able to adapt each learning session to the learner’s characteristics and environment, in order to increase learning efficiency and effectiveness, and learner satisfaction.

Notes:
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- short recap of scenario(s)  
*(Depending on the setting (industry or university), the respective scenario(s) have been provided to the interviewee in advance, requesting to read them as a preparation for the interview. Recapitulation of the scenarios and clarification of eventual questions. Discussion on the relevance of the scenarios.)*

Notes:

Please indicate how relevant the single scenarios are to you (highly relevant – partially relevant – non-relevant)!

### A) Current Usage

<p><b>A1.</b> Do you use any learning systems?</p> <p style="text-align: center;"><i>(if no: continue with questions A7 if yes: proceed with question A2)</i></p>	
<b>A2.</b>	Which learning systems?
<b>A3.</b>	How often?
<b>A4.</b>	How long have you been using learning systems?
<b>A5.</b>	Do the learning systems you have used so far provide any features of adaptation or personalisation to users?
<i>(if yes: proceed with question A6 if no: continue with question A7)</i>	
<b>A6.</b>	Which?
<b>A7.</b>	For what purpose or task are you using (or would you use) a learning system?
<b>A8.</b>	What are the benefits of using a learning system?

### B) Adaptivity Needs and Preferences

<b>B1.</b>	Do you think that there are purposes or tasks for which the use of an adaptive learning system is especially suited and which?
<b>B2.</b>	<p>Do you think that there are benefits in using an adaptive learning system? Do you think adaptivity in a learning system brings added value to the user?</p> <p>If so, which benefits/added value?</p> <ul style="list-style-type: none"> <li>• compared to non-adaptive systems, traditional teaching</li> <li>• for course author, teacher, learner</li> </ul>

**B3.** To which characteristics of the user or environment would you expect a learning system to adapt? - Which features should function as source of adaptation?  
*(Let the interviewee answer openly and list aspects that come into his/her mind; eventually refer to examples used in the adaptivity definition and scenarios, if question is not understood clearly)*

**B4.** I will now list features that are reported in the literature to function as source of adaptation, i.e. characteristics of learner or environment that may be considered by a learning system for adapting the learning process to the individual learner. Please indicate your opinion on the importance of adaptation to each of these features on a scale from 1 to 10 (1 meaning not at all important and 10 meaning very important/critical)!  
*(Please keep to the provided list and ensure that all the items covered are worked through and rated. Alternative wordings, explanations, or examples may be used.)*

<b>Adaptation criterion</b> (i.e. adaptation of learning system (learning content and activities, presentation, navigation etc.) to...)	<b>Explanation</b>	<b>Importance (1-10)</b>
– learner goals/tasks	adapting to the current learning goal or current learning task	
– learner knowledge and familiarity with the domain	adapting to prior knowledge and skills, performance level, current knowledge state	
– student qualification	adapting to the learner’s ability and quickness to acquire knowledge	
– background	adapting to the learner’s experience outside the subject	
– experience in the hyperspace	adapting to the learner’s ability to navigate in the internet	
– personal preferences	adapting to preferences with respect to system usage (tracked by the system or provided by the user), e.g. preferences in browsing hyperlinks	
– learning or cognitive style	adapting to differing patterns of behaviour and preferences related to acquiring knowledge and the learning procedure (e.g. visual, auditory, kinaesthetic; inductive vs. deductive)	
– personality factors	adapting to the learner’s personality style, i.e. stable features of a user on the personality dimension (e.g. introvert vs. extravert)	
– interests	adapting to the learner’s personal interests with respect to. certain content or objects	
– motivation	adapting to the motivational features of the learner (e.g. degree of achievement motivation)	
– language	adapting to the learner’s mother tongue and foreign language skills	

- user role	adapting to a user's (learner's) role in some situation/learning activity	
- platform	adapting to the hardware, software, network bandwidth etc. (e.g. personal computer vs. mobile device)	
- user location	adapting to the user's current location	

**B5.** In which way would you expect adaptation in a learning system? - What should be adapted and how should it be adapted?  
*(Let the interviewee answer openly and list aspects that come into his/her mind; eventually refer to examples in the adaptivity definition and scenario, if question is not understood clearly)*

**B6.** I will now list dimensions (including short explanations, if necessary) that can be subject for adaptation, i.e. technologies that may be used for adapting the learning process to the individual learner.  
 Please indicate your opinion on the importance of each of these adaptation dimensions on a scale from 1 to 10 (1 meaning not at all important and 10 meaning very important/critical)! For some of the dimensions I will also indicate specific techniques of how adaptation on these dimensions can be done. Please give your judgement for both, the dimension, in general, and the methods, in particular.  
*(Please keep to the provided list and ensure that all the items covered are worked through and rated. Alternative wordings, explanations, or examples may be used. Provide the explanations indicated in the table or alternative/additional ones for better understanding of each item.)*

<b>Adaptation dimension</b>	<b>Explanation</b>	<b>Importance (1-10)</b>
<b>adaptive content selection</b>	presenting information on a certain topic in different ways depending on learner characteristics	
- additional explanations	displaying additional information, illustrations, examples etc. matching the user's characteristics	
- prerequisite explanations	if prerequisites for a concept are not sufficiently known, the corresponding information is provided	
- comparative explanations	showing similarities between currently displayed concept and known ones	
- explanation variants	presenting the best fitting one of a set of different variants of a piece of information	
- sorting	fragments of information are sorted according to their relevance to the user	
<b>adaptive presentation</b>	adapt content of a hypermedia page to the user's characteristics) (= learning content personalisation)	
- adaptive text presentation	adapting the textual content of a page to the user	
- adaptive multimedia presentation or adaptation of modality	selection of the types of media to present to the user is based on the characteristics of the user (e.g. video, image, text etc., or combination of them)	

- customisation of the interface	adapting background colour, text size, style, arrangement of items on the page etc. to learner preferences/characteristics	
<b>adaptive learning activity selection</b>	selecting a suitable learning activity for the learner based on his/her characteristics	
<b>adaptive navigation support</b>	help learners find their path through hyperspace by adapting link presentation to learner characteristics	
- direct guidance	providing sequential path through the system using the 'next best' strategy (e.g. guidance with a 'next' button)	
- adaptive sorting	links of a document are sorted according to their assumed relevance (based on previous knowledge or similarity to current document)	
- adaptive hiding	links are hidden or disabled if the system assumes that they are not relevant and/or distracting	
- link annotation	links are annotated by text, colouring, an icon, or dimming in order to give some extra information to the learner	
- map annotation or adaptation	used for graphical overviews and/or maps	
- adaptive link generation (adaptive resource recommendation)	generating new links for a page - aiding users in decisions on matters related to personal taste through recommendations	
<b>adaptive problem solving support</b>	assisting the learner in problem solving	
- intelligent analysis of student solutions	providing the student with error feedback based on their final answers to educational problems	
- interactive problem solving support	providing the learner with intelligent help on each step of problem solving by giving a hint to executing the next step	
- example-based problem solving	helping learners to solve new problems by suggesting relevant successful problem solving cases from their earlier experience	
<b>adaptive assessment</b>	adaptive evaluation of learner's knowledge	
- adaptive testing	personalised explicit assessment in accordance with learner's performance - selecting problems depending on the learner's previous answers	
- adaptive questions	adapt appearance of questions (simple choice, multiple choice, fill-in-the-blank etc.) and/or scoring to the learner's skills	
<b>adaptive service provision</b>	the system selects from various available modules and widgets those that are appropriate for the user	
<b>student model matching</b>	analyse and match student models	
- adaptive collaboration support	forming a matching group of students for different kinds of collaboration	
- intelligent class monitoring	comparing records of different students and identifying mismatches (e.g. students that accessed much less material than others)	

**B7.** What functionality is essential for an adaptive learning system to be useful to you? In what way should it be presented to the user?

**B8.** Which other application areas of adaptive learning systems can you imagine?

**Thank you very much for your time and collaboration!  
It is a great help that you have shared your opinion with me!**

Further Notes:

### **A.3 Interview Data and Content Analysis**

#### **Summary**

In the following, the procedure and guidelines for recording the data gathered in stakeholder interviews in data sheets, as well as for analysing and categorising content of qualitative interview data is outlined. The data input and analysing procedure will be done using template provided in an Excel workbook together with these guidelines.

#### **1. Introduction**

The stakeholder interviews conducted for requirements elicitation of academic and corporate users will be documented in two forms, in individual interview summaries and in an overall interview data spreadsheet. Whereas the interview summaries are of narrative character and are targeted to give an overview of the conversation's content, the interview data spreadsheets serve for further analysis across interviews. The additional notes taken and noticeable occurrences and problems during the interview will basically only be reflected in the summaries of the interview. The interview data spreadsheets serve for content analysis of the qualitative data gathered in open questions and the use for further quantitative and statistical analysis across interviews. The guidelines for interview data and content analysis provided herewith give support in how to record interview data in the data spreadsheet and analyse and categorise the content of qualitative answers on the basis of the spreadsheet templates provided.

The interview guide created for the stakeholder interviews is designed to collect both, qualitative as well as quantitative data. There are open questions that try to gather information in an unbiased manner, without anticipating possible answers – and thus keeping the possibilities and range of answers open-ended and only restricted to the interviewee's imaginativeness. On the other hand, there are also some closed questions with pre-defined answer options, taking into account e.g. state-of-the-art in adaptivity research and development. The use of those different question types for the stakeholder interviews addressing the elicitation of adaptation requirements ensures that during the interview the interviewee becomes aware of personalisation technologies and principles that are already available and reported in the literature, but nevertheless leaving space for the generation and communication of new ideas that would not have been anticipated.

The diversity of questions and correspondingly the diversity of response data collected make a differentiated data input and analysis necessary. Whereas answers to closed questions can easily be coded and documented, qualitative data received from open questions require a more sophisticated way of content analysis and data input. This is done by the individual partners who carried out the interviews based on the guidelines and templates provided by this document. The results are then sent to task/WP leaders for

consolidation and will be reported in the requirements specification deliverables for university and industry settings.

A template workbook for interview data input has been created, where the data of all the interviews can be collected and documented. A comprehensive spreadsheet first collects the whole original data, i.e. all responses gathered in the interviews. The interview data received from the closed questions actually are similar to data gathered by a questionnaire. The responses to those questions are collected in the template by coding the responses in the spreadsheet through selecting the respective predefined answer option. The open responses are in the first step reduced to their basic content to so-called paraphrases and recorded in the spreadsheet. In a further step, the qualitative data is further analysed through a procedure of content analysis. After a short introduction to the topic of content analysis, in the following section the single steps of data input and analysis will be outlined and the use of the created templates will be explained.

## 2. Content Analysis

Content analysis refers to techniques of analysing texts and communication data, aiming in reducing large texts and qualitative data into a form condensed to its essential content (e.g. Stemler, 2001). On principle, all sorts of recorded communication, such as interview transcripts, discourses, observation protocols, documents, or video tapes, can be the object of content analysis (Mayring, 2000).

When talking about content analysis, some researchers differentiate between two approaches, quantitative and qualitative content analysis. While quantitative content analysis, which originated in communication science, rather focuses on counting word frequencies and in this way tries to come up to a systematic, objective, and quantitative description of the communication content (Rourke & Anderson, 2004), qualitative content analysis is rather guided by a qualitative-interpretative viewpoint and can be defined “as an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytic rules and step by step models, without rash quantification” (p.5). Most practical and appropriate seems the application of a combination of qualitative and quantitative analysis. This means to preserve advantages of both (Mayring, 2000), thus resulting in a systematic and replicable analysing procedure that is guided by qualitative text interpretation in order to get an in-depth understanding of the ideas and views of persons on the one hand, and also usable for further quantitative analysis (Schilling, 2006).

When carrying out a content analysis, this is always based on and driven by a research question and conceptual framework. Each step of the data analysis process is therefore done having in mind this starting point and perspective (Schilling, 2006). At the heart of content analysis is the development of a system of categories, which systematically summarises and reflects the qualitative data. For the development of such a category system two approaches can be distinguished, inductive and deductive category building (Mayring, 2000; Schilling, 2006). Deductive category development means to work with categories that have been formulated a priori and that characterize the aspects of analysis, by bringing them into relation with the text. On the contrary, inductive category development means to define categories as near to the material as possible, i.e. to formulate categories in terms of the material. Most often it will be the case that deductive and inductive strategies are combined to build categories, as often the researcher will not start from scratch, but rather have in mind a rough idea of categories based on prior research or derived from theory (Schilling, 2006).

To enhance the process of carrying out content analysis and to support the steps of interpretation also computer programs exist (Alexa & Zuell, 2000). The use of such software is especially suited in case of large databases. Although the software typically does not support the process of content analysis itself as it does not release the researcher from taking decisions and shaping the analytic process, but it is helpful for managing, recording, and retrieving the textual data (Schilling, 2006).

## 3. Guidelines for Data Input and Content Analysis

This section provides guidelines for the input and recording of the interview data and their further analysis. This process is described in a step-by-step manner, covering the recording of all types of questions and the content analysis of the qualitative data gathered. The procedure for content analysis is based on the approaches outlined in Schilling (2006) and Weibelzahl et al. (2006).

Note, that for our purpose, i.e. in the context of analysing users' needs and opinions regarding adaptation, we purely focus on the content of answers. Characteristics of communication and speech, such as

intonation, pauses etc. might provide valuable information in other contexts (e.g. psychotherapy research), however they are also not easily and unambiguously interpreted (Schilling, 2006). Focusing on the answers only also has the advantage of giving the interview data of different interviewers and partners a more coherent form and makes forthcoming steps of analysis and consolidation of results easier.

### 3.1. Step 1: Preparation

In the scope of requirements analysis in GRAPPLE the content analytic process should be based on the aim of identifying and investigating users' needs towards adaptivity of learning systems. Before starting the data input and analysis process therefore make yourself again aware of this general purpose. The experiences, needs, opinions, and ideas of the users are at the centre of interest. Consider during the whole process also the technologies and principles of adaptation and personalisation reported in the literature and actually technologically implemented (basically what is covered by the closed-ended questions B4 and B6 in the questionnaire), as having this in mind will be helpful for the categorisation of the qualitative material.

The data input is done in accordance with the structure of the interview guide. The units of data input and analysis are the single questions.

Data input is done in the provided Excel workbook 'GRAPPLE\_Interview-Data-Templates', which provides a range of templates for recording the interview data and for content analysis of the open-ended questions. The spreadsheets have frozen panes where appropriate, in order to increase overview. Furthermore, panes that should not be changed (e.g. cells containing formulas) are locked.

### 3.2. Step 2: Recording and condensing raw data

This subsection first provides an overview on the spreadsheet template and the principles for filling in the interview data in this template. Subsequently, a detailed description on the data input for each question is provided.

#### Basics on the data spreadsheet and fill-in procedure

In a first step the interview raw data, which are actually the notes taken during the interview and documented in the interview protocol, is condensed and recorded in the spreadsheet 'Data Sheet'. This means that the interview protocols serve as a basis for data input. Please note that this documentation needs to be in English (even if the interview itself was carried out in another language).

To record the interview data for all interviewees and all questions a spreadsheet template has been created (in Excel format, which also allows to be carried over in an SPSS file for the purpose of further statistical analyses). This comprehensive spreadsheet gives a tabular overview over all interviews carried out and questions posed whereas the interview summaries are of narrative character and mainly are aimed to give an overview of the basic content of the interview prior to further analysis and categorisation.

The data of each interview is typed into the spreadsheet with the individual cases (i.e. interviews) in rows and with columns representing the single questions. To ease the process of filling in the interview data, explanations are provided, when clicking in the cells dedicated for data input.

Answer options: For questions where only a limited set of responses are expected or, respectively, where answer options were indicated in the interview guide, the answer categories are already contained in the spreadsheet and the respective answer of an interviewee has simply to be selected accordingly from the dropdown list. For the question on the frequency and incidence of learning system use (questions A3 and A4) preliminary categories have been created, that were assumed to be appropriate. This increases immediate comparability between interviews. Nevertheless, the original answers to the respective questions are also recorded in the data spreadsheet, in case that it is discovered that the chosen categories are not able to differentiate sufficiently. For questions B4 and B6, i.e. the importance ratings on adaptivity criteria and technologies, each sub-category of the respective question represents one column.

Open answers: For open-ended questions most probably there might be several separate answer statements for only one question. For each interviewee, these are nevertheless typed in within only one cell of the spreadsheet. The individual columns representing all the text responses will then be used for creating answer categories through content analysis (see Step 3). The respective columns are accordingly marked in light grey. For some questions the answer might only be a listing of words or instances (e.g. names of learning systems). For other questions, much longer responses will have been occurred, involving more

extensive explanations and descriptions. Especially the latter require further condensing through paraphrasing (see below).

It might be rarely possible that an answer given to a certain question is actually more related to another question. In this case re-assign and document the respective answer to that more relevant question. It may also be the case that information collected in the additional notes (e.g. during the recapitulation of the scenarios or excursive conversation) might appear relevant for a certain open question, and should therefore be documented for the respective question.

Paraphrasing open answers: Open answers should be condensed to its basic information. This procedure provides a better overview and readability of the data and prepares the interview data for further content analysis. To this end, the original answers are reduced while preserving their basic content by omitting words that are not necessary for understanding the given statement. In other words, sentences are transformed into a short form, yielding generalized and reduced statements. The necessity of paraphrasing arises of course much more urgently if interview transcripts are used. As in our case the data input relies on the interview notes, the notes themselves will actually already represent kind of paraphrased answers, but there may still be filler words and statements by which the answers can be further reduced for data input in the spreadsheet.

Be aware, that within one statement there might occur actually a conjunction of answers. For instance, the interviewee may list different features for adaptation within one sentence. Dissolve such conjunctions and record them separately (see Table 1, example 2).

On the other hand, it might be the case that a certain type of answer statement reoccurs (in identical or different wording) within an answer. Merge such recurrent statements into one paraphrased answer statements.

Example	Original answer	Paraphrased answer statements
1	Let me think about that. I think when learning with an e-learning system it is very important that the student is provided with learning material that actually corresponds to his learning goal.	Learning material corresponding to learning goal.
2	Hm, that's a good question. Learning activities should be tailored to the learner's prior knowledge and his interests. Yes, I think that's most critical.	Learning material tailored to learner's prior knowledge. Learning material tailored to learner's interests.

Table 28: Example for paraphrasing statements.

### Description of data input for each question

Please find below detailed descriptions on data input in the 'Data Sheet' template for each question, corresponding to the structure of the interview guide. The respective column headings are indicated and information on the data to be filled in is provided. If existing, answer options are listed – these are provided as dropdown list in the spreadsheet, and the appropriate option has to be selected. Open answers need to be paraphrased as outlined above; the respective columns are marked in light grey and are subjected to further analysis in subsequent steps.

If no answer could be collected to a particular question leave the respective cell blank.

Carry out the process of data input into the spreadsheet very carefully and make sure that you always fill in the correct answer in the correct column and row!

In addition to the explanations provided below, short hints on data input are provided directly in the spreadsheet when clicking in the respective cells.

### Basic information:

Column	Explanation	Answer options
--------	-------------	----------------

<i>heading</i>		
setting	Select interview setting from dropdown list.	university industry
partner	Select short name of your institution from dropdown list.	TUe OUNL LUH VUB Warwick USI UniGraz DFKI TCD UCL UCAM GILABS IMC ATOS
date	Insert date of interview in the following format: DD.MM.YYYY, e.g. 19.05.2008	
place	Type in place/city where the interview was conducted.	
interviewer	Type in the interviewer's name.	
interviewee code	Type in the interviewee code, consisting of the interviewee's birth year and his house-number, in the following format: YNNN  e.g. 65017 (for birth year 1965 and house-number 17)	
stakeholder group	Select stakeholder group from dropdown list.	learner training provider other
job role	Type in interviewee's job role or function (with respect to. to his/her stakeholder group).	

A) Current Usage

<i>Column heading</i>	<i>Explanation</i>	<i>Answer options</i>
A1	Select 'yes' or 'no' from the dropdown list for the question A1.	yes no
A2	Type in the learning systems indicated by the interviewee in question A2 in paraphrases.  Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers': <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	
A3	Type in original answer to question A3.	
A3_cat	Select option of the predefined categories from dropdown list appropriate for original answer to A3.	daily

		<p>one to several times a week</p> <p>one to several times a month</p> <p>one to several times a year</p> <p>hardly ever</p>
A4	Type in original answer to question A4.	
A4_cat	Select option of the predefined categories from dropdown list appropriate for original answer to A4.	<p>for years</p> <p>about 1 year</p> <p>for months</p> <p>for weeks</p>
A5	Select 'yes' or 'no' from the dropdown list for the question A5.	<p>yes</p> <p>no</p>
A6	<p>Type in the features of adaptation indicated by the interviewee in question A6 in paraphrases.</p> <p>Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers':</p> <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	
A7	<p>Type in the purposes/tasks indicated by the interviewee in question A7 in paraphrases.</p> <p>Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers':</p> <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	
A8	<p>Type in the benefits indicated by the interviewee in question A8 in paraphrases.</p> <p>Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers':</p> <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	

B) Adaptivity Needs and Preferences

<i>Column heading</i>	<i>Explanation</i>	<i>Answer options</i>
B1	<p>Type in the purposes/tasks indicated by the interviewee in question B1 in paraphrases.</p> <p>Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers':</p> <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell</li> </ul>	

	(Alt+Enter)	
B2	Type in the benefits indicated by the interviewee in question B2 in paraphrases.  Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers': <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	
B3	Type in the adaptation criterions indicated by the interviewee in question B3.  Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers': <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	
B4_1	Select the importance indicated for adaptation to learner goals/tasks.	1-10  (with 1 meaning not at all important and 10 meaning very important/critical)
B4_2	Select the importance indicated for adaptation to learner knowledge and familiarity with the domain.	1-10
B4_3	Select the importance indicated for adaptation to student qualification.	1-10
B4_4	Select the importance indicated for adaptation to background.	1-10
B4_5	Select the importance indicated for adaptation to experience in the hyperspace.	1-10
B4_6	Select the importance indicated for adaptation to personal preferences.	1-10
B4_7	Select the importance indicated for adaptation to learning or cognitive style.	1-10
B4_8	Select the importance indicated for adaptation to personality factors.	1-10
B4_9	Select the importance indicated for adaptation to interests.	1-10
B4_10	Select the importance indicated for adaptation to motivation.	1-10
B4_11	Select the importance indicated for adaptation to language.	1-10
B4_12	Select the importance indicated for adaptation to user role.	1-10
B4_13	Select the importance indicated for adaptation to platform.	1-10
B4_14	Select the importance indicated for adaptation to user location.	1-10
B5	Type in the adaptation technologies indicated by the interviewee in question B5.  Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers': <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	

B6_1	Select the importance indicated for adaptive content selection.	1-10
B6_2	Select the importance indicated for additional explanations.	1-10
B6_3	Select the importance indicated for prerequisite explanations.	1-10
B6_4	Select the importance indicated for comparative explanations.	1-10
B6_5	Select the importance indicated for explanation variants.	1-10
B6_6	Select the importance indicated for sorting.	1-10
B6_7	Select the importance indicated for adaptive presentation.	1-10
B6_8	Select the importance indicated for adaptive text presentation.	1-10
B6_9	Select the importance indicated for adaptive multimedia presentation or adaptation of modality.	1-10
B6_10	Select the importance indicated for customisation of the interface.	1-10
B6_11	Select the importance indicated for adaptive learning activity selection.	1-10
B6_12	Select the importance indicated for adaptive navigation support.	1-10
B6_13	Select the importance indicated for direct guidance.	1-10
B6_14	Select the importance indicated for adaptive sorting.	1-10
B6_15	Select the importance indicated for adaptive hiding.	1-10
B6_16	Select the importance indicated for link annotation.	1-10
B6_17	Select the importance indicated for map annotation or adaptation.	1-10
B6_18	Select the importance indicated for adaptive link generation.	1-10
B6_19	Select the importance indicated for adaptive problem solving support.	1-10
B6_20	Select the importance indicated for intelligent analysis of student solutions.	1-10
B6_21	Select the importance indicated for interactive problem solving support.	1-10
B6_22	Select the importance indicated for example-based problem solving.	1-10
B6_23	Select the importance indicated for adaptive assessment.	1-10
B6_24	Select the importance indicated for adaptive testing.	1-10
B6_25	Select the importance indicated for adaptive questions.	1-10
B6_26	Select the importance indicated for adaptive service provision.	1-10
B6_27	Select the importance indicated for student model matching.	1-10
B6_28	Select the importance indicated for adaptive collaboration support.	1-10
B6_29	Select the importance indicated for intelligent class monitoring.	1-10
B7	Type in the functionalities indicated by the interviewee in question B7.  Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers':	

	<ul style="list-style-type: none"> <li>- Omit unnecessary words</li> <li>- Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</li> </ul>	
B8	<p>Type in the application areas indicated by the interviewee in question B8.</p> <p>Reduce the answer to its basic content as described above in the subsection 'Basics on the data spreadsheet and fill-in procedure' under 'Paraphrasing open answers':</p> <ul style="list-style-type: none"> <li>- Omit unnecessary words</li> </ul> <p>Dissolve conjunctions of different answers and type them in by using commas and/or line break within cell (Alt+Enter)</p>	

### 3.3. Step 3: Content analysis of open answers

Further content analysis is carried out for the questions A2, A6, A7, A8, B1, B2, B3, B5, B7, and B8 with the aim of establishing categories of answers across the interviews. This will allow determining categories of user requirements towards adaptation, increase comparability of interviews, enable quantitative analysis of with respect to. those requirements, and ease the consolidation for being reported in the requirements specification deliverables.

For aggregating and synthesizing the open answers and establishing categories for them, the approach used and outlined by Weibelzahl et al. (2006) will be applied. This approach is based on and inspired by the principles of the content analytical research tradition of grounded theory (Strauss & Corbin, 1990). Please find below a description of how to proceed in the analysing procedure.

#### ***Procedure for content analysis and answer category development***

- The content analysis is done question wise.
- For each question a separate spreadsheet has been created for further analysis (e.g. for question A2 with the title 'A2\_analysis'). The first two columns in the spreadsheet contain the original data which is taken over from the data sheet.
- Start with the answer of the first interviewee.
- Most probably, the answer will contain several different (paraphrased) answer statements. Deal with each of them separately.
- The first answer statement of the first interviewee constitutes the first answer category for the respective question. Please record the interviewee code and the respective statement in the column 'answer statement' of the columns with the headline 'CATEGORY 1'. The counter for the answer frequency of this category will automatically change to '1'.
- Try to find an appropriate category name and insert it in the respective cell (to the right of 'CATEGORY1:').
- Subsequently, take the next answer statement of the same interviewee, if there. Otherwise, take the first answer statement of the next interviewee. Compare the statement to the previous one (try to find commonalities and differences).
  - If the answer statement is similar and can be subsumed under the same category as the one before, document it under category1. Insert the interviewee code only if the answer statement refers to a different interviewee! The counter for the category will automatically be set from 1 to 2. If the statement was given by the same interviewee as the one before, do not indicate the interviewee code again (within one category) – this is not counted for the answer frequency of the category.
  - If no sufficient similarity and applicableness of the answer statement under consideration can be encountered for the existing category, then the statement is added to the next category together with the interviewee code (again a category name needs to be defined).

- Go ahead in the same manner. Take the next statement and compare it with the already existing categories. If it can be related to one of them, record it under the respective category. If the statement refers to a new type of answer, create a new category. (Twenty categories are provided in the respective template for each question, which should assumingly suffice. If you result in more categories, copy and paste the form for the additional categories.)
- When the analysis for one question is done, i.e. all statements have been taken into account and categorised, review the categories to check whether they developed set of categories represents the interview data well.
- Once the processing of a question is concluded, the analysing procedure for the next question can start.

When doing the analysis in the above described way, please pay attention to the following:

- Take care that you mindfully compare and relate statements with existing categories. Do not subsume clearly identifiable different aspects and topics under one category. Do also not arbitrarily create new categories for actually quite similar answers. For analysing and creating answer categories for the open answers on adaptation criteria and technologies (B3 and B5) also keep at the back of your mind the criteria and dimensions that are indicated in the respective closed-ended questions (B4 and B6). The general aim of content analysis and category development is to end up with a set of meaningful categories, that reflect the purpose of our research, and that are exhaustive and mutually exclusive (Schilling, 2006).
- Make sure that you carefully document the interviewee codes and answer statements that are associated with a category! Indicate a certain interviewee code only once within one category, and do not repeat it for further answer statements of the same interviewee that are associated with the same category. The interviewee code and answer statement is recorded for the categories because of several reasons:
  - This makes it possible to identify which interviewees gave an answer for the respective category. Ensure that you use the correct interviewee code! This is essential for the correct automatic registration of answer categories per interviewee.
  - It enhances the process of categorising further responses. Answer statements can more easily be related to a certain category.
  - Listing the paraphrases for each category is also helpful for category development and naming, as you may recognise or it may occur to you at some point that another category name would be more suitable or better describe the respective category.
  - It enhances work for the consolidation of the interview results. In this way it is easier to compare category systems that are the result of different partners.
  - Apart from frequency counts for each category, in this way concrete examples of answer statements for the respective category can be given. This serves for a more detailed description of identified user requirements and preferences in the deliverables.
- After having analysed and processed all answers for all questions, check whether the resulting answer categories still represent sufficiently well the answers that were originally given by the interviewees.

#### **3.4. Step 4: Data consolidation - Aggregating categories**

When all partners have concluded the input and analysis of their interview data, the results (i.e. the completed data sheets in the template workbook together with the interview summaries) are sent to the WP leaders and deliverable editors for consolidation. In the phase of consolidation the category systems built by the partners need to be carefully gone through and investigated, in order to find commonalities among them. The aim of this consolidation process is to reach one aggregated category system that is able to capture the interview results of all partners, such that in the end overall frequencies (i.e. across all interviews) for the individual categories can be given.

In the following, the process of consolidating the interview data and aggregating and harmonizing the category systems developed by partners for the open questions is described, which will be carried out by the

deliverable editors of D9.1 and D10.1. To this end, first the interview original data is merged into one comprehensive data sheet. Subsequently, for each question the derived categories are aligned.

- Take the interview data sheet of one of the interviewing partners as a basis for the merging of the interview data. Preferably, take the sheet of your own institution, as you will be most familiar with it. Save the excel file under a new name for the merged interview data (in the following, this file is called 'merged file').
- Copy and paste the interview data rows of the interviews carried out by all the partners from their individual data sheets into the newly created Excel file. As a result you will have a data sheet with the original data from all interviews carried out in the respective work package.
  - Preferably, work through the partners' data in the same sequence as inserted in the data sheet for the following steps.
- In a next step, the analysis of the open questions has to be aligned, i.e. category aggregation has to be carried out. This is done question wise. Starting point for each question is the category system developed by your own institution based on your interview data, which will already be contained in the merged file.
  - Start with the first open question.
  - Have a look at the analysis done for this question by the first partner. Take the first category found by the partner and compare it with the categories already available on the respective sheet in the merged file. Try to find similarities and overlaps (to this end, also try to compare and find commonalities among the respective answer statements). For instance, sometimes there will possibly have been used different category names by for almost the same category of answer statements.
    - If the category of the respective partner is similar to one of the categories already there, the respective answer statements can be subsumed under the same category. For this, copy the interviewee code and answer statements from the partner's data file to the merged file. The counter for the category will be updated accordingly. In the course of this, you might also want to slightly update or revise the category name.
    - If there is no sufficient similarity between the partners's category with the categories in the merged file, create a new category. Insert the respective (or an updated, suitable) category name. Copy and paste the interviewee code and answer statements belonging to the respective category from the partner's file to the merged file. The counter will be automatically set to the respective answer frequency.
  - Go ahead in the same manner. Take the next category for the respective question of the same partner (if there) and compare it with the categories already in the merged file. If it can be related to one of them, record the relevant interviewee codes and statements under the respective category. If the category refers to a new type of answer, create a new category.
  - Once the categories of one partner have been gone through and aligned, take the data for the next partner for the same question and proceed in the way described above, until the categories of all partner have been handled and aggregated for this question.
  - When the consolidation for one question is done, review again the categories and check whether there are no reoccurrences and whether the aggregated category system represents the interview data well.
  - Once the category aggregation of a question is concluded, the consolidation procedure for the next question can start.

When going through this consolidation procedure, please pay attention to the following points:

- There might be partners that did not carry out the preliminary content analysis for the open answers of their interview data. Consequently, there will not be a category system that can be compared and aligned with the categories in the merged file. In this case, you will have to carry out the content analysis for the answer statements of the respective interviewees in the merged file as described under Step 3. Identify the interviewee codes of the respective interviews and work through the answer statements as described there.

- Compare and relate categories mindfully with each other. In the course of consolidation you might want to modify the category name to a more suitable one. With respect to adaptation criteria and technologies you should also bear in mind the answer options that have been provided for the closed-ended questions.
- It is important, that for each category the interviewee code and the answer statements of the interviewees that have responded in the respective category are indicated. The correct interviewee codes need to be there in any case – this is essential for the counting of the answer frequencies of the respective category (category-wise and also interviewee-specific!)
  - o Note, that for one and the same category, the interviewee code of one and the same person should only be indicated once – even if there are several answer statements of the same person that can be encountered for this category.

### 3.5. Step 5: Working with the results of content analysis

In the interview data workbook for each question the frequencies for the single answer categories are automatically counted within the respective analysis spreadsheets. In the spreadsheet 'Summary\_Analysis', for each interviewee and answer category it is automatically indicated whether the respective interviewee gave a response of this category (indicated by 1) or not (indicated by 0). This data can later on together with the data from the 'Data Sheet' be taken over to SPSS and be used for further descriptive and statistical analysis.

In this way, the absolute topic frequency can be indicated, i.e. the total number of times a certain category has been addressed. Furthermore, also frequencies for groups of stakeholders can be indicated. By utilising the answers on the questions B3 and/or B4 on the use of learning systems (how long and how often, respectively) to cut the sample in two groups of interviewees, i.e. experienced and non-experienced ones, also for those groups answer frequencies can be indicated. In this way, it is also possible to evaluate how representative the statements are for the whole sample. More complex methods for analysing the categorical data can be done in order to statistically compare subgroups (stakeholders, experienced/inexperienced users).

Statistical methods will also be applied for further analysing the interview data on the closed-ended questions, like the importance ratings for adaptation criteria and technologies. This will allow not only to indicate the mean importance ascribed to the individual aspects of adaptation, but also to make group comparisons (e.g. whether a certain technology has been judged significantly more important by a certain stakeholder group).

The goal of the concluding report on user requirements in the deliverables will be not only to produce answer counts, but rather to provide overall, meaningful information on the interviews. This includes systematically built categories of answers for the individual open-ended questions, appropriate descriptions of these categories and meaningful numerical analysis and interpretation of answer frequencies. This will also involve systematic group comparisons, and finally also narrative descriptions of interviews and experiences therein. In this way, a comprehensive and in-depth understanding of the requirements, preferences, and opinions of users towards adaptation can be reached and documented.

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## B Interview summaries

This section includes the text summaries of the interviews conducted by each of the participating partners (indicated by the partner acronym) and is based on their individual transcripts of the interviews. Since the interviews are confidential, each partner was asked to include a generic description/context of the interviewed organization as well as any particularities not reflected in the content analysis. This section is ordered by profile (learner, training provider and other).

### B.1 Learner Profile

#### B.1.1 Interview Code 80037 (TCD)

The interview with the interviewee 80037 was conducted on 3<sup>rd</sup> June 2008 in Dublin. The interviewee was a final year undergraduate student and undertook a final year project in the area of AH. The scenarios were very familiar to him. He was already familiar with the concept of adaptivity in LMSs. The interviewee had experience with in-house e-learning software. Furthermore, he had developed his own adaptive music recommendation system using techniques from AH. He saw the main benefits of using an adaptive LMS as being the possibility of personalized learning goals and adaptation to user preferences and locale.

An adaptive LMS for the interviewee appears especially suited to the diverse environment within a university. He would like an adaptive learning system to adapt to prior knowledge, learning goals, locale, modality, learning styles and preferences of a user. The learner should be able to indicate his/her characteristics through filling out some kind of questionnaire and by automatic system observation of the user. The system should provide an overall view of what the learner needs to do to complete a course satisfactorily. Adaptive dimensions that are judged the most important are adaptive presentation, navigation, and the structuring of content. The features that the interviewee would expect from a learning system are the provision of relevant feedback and the possibility of indicating preferences and prior knowledge/abilities. The user should always be aware of adaptation, both implicit and explicit. Application areas include intelligent recommendation systems and the delivery of multimedia content (e.g. for short or long biographies depending on the device).

#### B.1.2 Interview Code 82291 (WARWICK)

The interview with the interviewee 82291 was conducted on 14<sup>th</sup> June 2008 in Coventry. The interviewee is a PhD student of computer science. The scenarios were understandable to him. The demonstration of the AHA! system was helpful to provide the interviewee with an idea of what an adaptive system is. The interviewee had some experience with e-learning software such as Sakai. Furthermore, he had been using Sakai at university in the context of a lecture, using communication tools between students and between students and training provider. The main benefit of using a learning system, he sees, is the possibility for distance learning. An adaptive learning system for the interviewee appears especially suited for 'recommendation systems'. Adaptation should be based on collaboration and users activities. He thinks the recommendation of content should be adapted. The essential functionality of an adaptive learning system is the provision of related materials via recommendation systems. He thinks other application areas of adaptive learning systems are 'systems that are triggered by the users rather than predefined assumption'.

### **B.1.3 Interview Code 08212 (VUB)**

Interviewee 08212 was a female master's student in computer science. She was of African origin, which was clearly reflected in some of her answers during the interview. English was not her native language. Nonetheless, the interview was conducted in English.

The interviewee had no prior knowledge on the topic of adaptivity. However, she was well prepared. In advance of the interview, she had read all the scenarios and she also extensively tested an example BBC language course. In terms of the scenarios, she obviously found that the student scenario was most relevant for her being a student. The other scenarios were more difficult to understand, especially without a lot of background information on the adaptivity and online learning applications. The example course was the most useful for her to understand the actual concept of adaptivity and the idea of making adaptive applications. Although, she did not know anything about all the different characteristics on which adaptation can happen, she could already deduce some of them (and also their intention) by just going through the demo.

The only online learning environment with which the interviewee was familiar was PointCarre. This was an in-house system developed at VUB. PointCarre is based on an open source system called Dokeos. In the computer science department of VUB, it is not trivial to use these kinds of systems so most teachers do not use it at all or have their own personal wiki system. However, some teachers do use it but then only for uploading course documents. The interviewee did see some benefits in using the system, especially with regards to planning. It is believed that students nowadays are poor planners and have many difficulties meeting their project deadlines. If the calendar and the mailing service are effective, it would help the students in this task. For example, all the deadlines for assignments could be integrated in the calendar and personalized for each student. Alerts could then be sent out in time to remind them of the upcoming deadlines.

The interviewees' cultural differences resulted in some criteria being more important, e.g. the platform and user location. In her country, it is not common to have computers with high bandwidth and large fully interactive web applications are much more difficult to use. Adaptation to learning or cognitive style was deemed to be of very low importance since she already noted that it is almost impossible for people to take the time to create all this material. In contrast, she did find that having adaptive multimedia or other modalities is very important since students like pictures and videos more than just ordinary text.

### **B.1.4 Interview Code 82002 (USI)**

This interview was done at the University of Lugano, at the end of course term. The interviewee was a very capable student. In his opinion, the main weaknesses of the demo scenario were that the tutor has to understand the student's learning objectives and has to elaborate a suitable learning plan. The time needed to understand the learning objectives may be too much and, sometimes, even impossible. He thinks that an adaptive system could be an improvement over traditional e-learning tools, but that is not comparable with the face-to-face experience. He feels that adaptive systems are useful to study and review materials but ineffective in the whole learning process. He used Moodle for two years, more or less once a week; to find information, download materials, communicate with peers, use discussion forums, etc. The main advantage was time saving, with the possibility of finding relevant information easily. He thinks that adaptive systems are more useful for artistic fields and language learning. The main adaptation criteria could be the goals and tasks of the user, the learner's abilities and speed in acquiring new knowledge, the cognitive style and the native language or the level of foreign language that the student has. The adaptation layer can be at the content level in an automatic way and at the presentation level under the explicit influence of the user. He thinks that the adaptation dimensions can be the prerequisite explanations, the selection of different media and the adaptive selection of learning activities. Further interesting dimensions include the adaptive sorting and annotation of links, and personalized problem solving support. Key features that are necessary in such systems are problem solving support, the availability of a communication channel with peers, smart feedback and evaluation, together with a differentiated management of content at a medium level. Some other domains of applicability of an adaptive learning system are, lessons that require a large amount of experimentation, for example through simulations, and where the right level of stimulus is needed, in respect of motivation.

### **B.1.5 Interview Code 82004 (UniGraz)**

The interview with the interviewee 82004 was conducted on 3<sup>rd</sup> June 2008 in Graz. The interviewee is a student of psychology (14<sup>th</sup> term). The scenarios were in general understandable to her, except the author scenario was not completely clear. The demonstration of the AHA! system was helpful to provide the interviewee with an idea of what an adaptive system is. The interviewee has experience with e-learning

software for typewriting and vocabulary. Furthermore, she had been using WebCT at university in the context of a lecture, where communication among students and with the lecturer was done and homework documents were submitted using this system. Even a written exam was carried out using this system. The main benefit of using a learning system she saw is the possibility for synchronous and asynchronous communication and documentation. An adaptive learning system for the interviewee appears especially suited for learning languages and other basic knowledge, but also when doing studies of medicine. She thinks that traditional courses are boring, as the learner might be presented with contents the learner already knows, which might increase the rate of drop-outs. In the case of an adaptive system, though, the learner can be provided with contents that she is ready to learn. Consequently, the learning system should adapt to the prior knowledge, learning goals, and preferences of the learner. Adaptation should be done in a way that the learner could first indicate his/her characteristics through filling out some kind of questionnaire. The system should subsequently track learner characteristics and make the learner aware of inconsistencies (between profile information indicated in the questionnaire and tracked during system use). Furthermore, the comparison with other learners should be possible. Adaptation dimensions that were judged the most important were adaptive content selection, adaptive navigation and problem solving support, adaptive assessment and adaptive service provision. Essential features that the interviewee would expect from a learning system are the provision of feedback and the possibility of indicating preferences and prior knowledge/abilities, and adaptation according to this information. Application areas she sees are pre-university and university education, particularly for languages, vocabulary learning and mathematics.

### **B.1.6 Interview Code 84002 (UniGraz)**

The interview with the interviewee 84002 was conducted on 3<sup>rd</sup> June 2008 in Graz. The interviewee is a student of psychology. The learner scenario was comprehensible to the interviewee; the other scenarios she deemed less relevant for her and therefore harder to understand. The demonstration of the AHA! system provided further insight into the notion of adaptivity. The interviewee has regularly used the WebCT system in the context of a university lecture. The benefits of using learning systems, she saw, included time saving for the lecturer, and the possibility of keeping a good overview of the lecture and communication therein. An adaptive learning system, she thought, was especially useful for learning clearly defined knowledge domains, but not for very large and broad knowledge domains or for carrying out whole studies. Compared to non-adaptive systems, the benefit of adaptive systems lies in the possibility of tailoring the learning process to the abilities of individual learners. Compared to traditional teaching, where this is also possible to a certain extent, adaptive systems have to advantage of realizing adaptation much more efficiently. For the interviewee the most important adaptation criteria are learner knowledge, goal, and student qualification. Adaptation should be realized in terms of adapting the learning content and its complexity, the assessment process, and the design of the learning system. The most relevant application fields, she saw, were in learning languages and mathematics, and also for acquiring knowledge on complex theories in an interactive manner. The interviewee indicated that she would change the rating scale used for the importance ratings - in order to enable the indication of aspects of adaptivity that should not be implemented.

### **B.1.7 Interview Code 81023 (OUNL)**

This interview was conducted on 26<sup>th</sup> May 2008 in Heerlen. The interviewee was a PhD student at OUNL. The scenarios were in general understandable to him; just the author part seemed to be vague and too difficult to understand for people unfamiliar with adaptivity. He thought authoring is a demanding task that should be done by a team. The tutor scenario means a lot of work for the tutor initially, if he has a lot of students. He liked the idea of visualizing the learning process. From a student point of view, he raised an interesting issue - 'how do I know that I haven't missed anything important?'. He considers all three scenarios as partially relevant to him. The interviewee has not used any learning system yet. He would use it as a direct help to support his work, but he prefers personal face-to-face contact. As regards the benefits of a learning system, he mentions an overview of the skills needed and guidance. An adaptive learning system for the interviewee appears especially suited for learning procedural skills (e.g. how to put together an engine) and to support various learning approaches (e.g. a holistic one). For students, it can provide efficient learning with a reduced amount of information provided to the person. For tutors, it gives a good overview of learners' skills. However, for authors, it generates more work. One interesting issue raised by the interviewee is a potential conflict between learner's preferences and optimal learning. According to him, the system should adapt to prior experience, prior knowledge, and learning style of the learner. It should adapt the learning plan, selection of learning resources (appropriate media type), the learning strategy (based on prior results and choices), the assessment (based on former assignments), and also provide adaptive problem solving support. Essential features that the interviewee would expect from an adaptive learning system are ease of use and a simple, accessible user interface. Other application areas he saw were in the learning of

theoretical knowledge, as he considers this difficult for practice oriented learning. The interview lasted approximately 100 minutes.

### **B.1.8 Interview Code 84001 (OUNL)**

The interview with the interviewee 84001 was conducted on 9<sup>th</sup> June 2008 in Verviers. The interviewee was in his final year of history studies. The interviewee had no experience with e-learning software. The demonstration of WINDS and the BBC English Course were helpful to provide the interviewee with an idea of what an adaptive system is. The interviewee fears that adaptive systems make learning decisions in place of the students while the most fruitful result of a university training are precisely internalized abilities to make learning decisions, i.e. 'the historian is not the person who knows but the person who knows where to search'. Students develop skills by trying different methods, making mistakes or observing what works well. For the interviewee, learning must remain in the hands of the students and if a system makes a decision, the students should be involved. The interviewee finds the scenario document understandable but unrealistic, i.e. 'there is no such thing at university as individualized support; for academics, we are no more than numbers'. According to the interviewee, personalization already exists as students are allowed to choose a growing number of options as years go by. The interviewee is in favour of choice only if it does not threaten the acquisition of a general background and the covering of inescapable notions. The interviewee could find a use of adaptive systems if such systems can automatically connect with native speakers when studying languages. He believes also that adaptive systems might be helpful to students who are not aware of their weaknesses and are unable to 'personalize' their learning. For those students, an adaptive system could identify styles and train to their best contextual use. Adaptation criteria judged as being the most important were learning goal/tasks, student qualification, learning styles, interests, motivation, language, and platform. However, the interviewee persisted with his view that 'minimal personalization involving the student is better than fully automated personalization'. The support of technologies should not infantilize but promote a student's responsibility in a framework and should not be too anarchic but prompt enthusiasm for learning.

## **B.2 Training Provider Profile**

### **B.2.1 Interview Code 60063 (TCD)**

The interview with the interviewee 60063 was conducted on 17<sup>th</sup> June 2008 in Dublin. The interviewee was a computer science lecturer. He had briefly used e-learning systems when teaching courses, mainly for the delivery of notes and as a central repository for examples and links to further material. He considered the main benefits of e-learning systems to be the ease of distribution of lecture and class notes and automated tracking and reporting. The scenarios were very familiar to him. He was also somewhat familiar with the idea of adaptivity in LMSs.

He has found e-learning systems very useful for technical material where students have some knowledge but require more detail. They can do this in their own time. The authoring of courses that are similar but require small changes, for instance, undergraduate and postgraduate-level courses, could be made much easier through the re-use of learning material. However, it is important that the system provides 'more than a web page'. The profit must be greater than the effort. The user should see all forms of adaptation and always feel in control. Any type of training organization can benefit from this type of system. The system should adapt to prior knowledge and learning styles and should be able to adapt the content and navigation or link-structure.

### **B.2.2 Interview Code 18016 (TCD)**

The interview with the interviewee 18016 was conducted on 10<sup>th</sup> June 2008 in Limerick. The interviewee was a computer science lecturer. He used e-learning systems when teaching courses, particularly Moodle. He used it mainly for the distribution of notes and as a central repository. He considers the main benefits of e-learning systems to be the ease of distribution of lecture and class notes and the re-usability of the content for similar courses, e.g. the same course the following year. The scenarios were somewhat familiar to him. He was not familiar with the idea of adaptivity in LMSs.

He thought that an adaptive learning system should adapt to prior knowledge, previous performance and ability (e.g. mid-term results), learning styles and preferences. The system should adapt the course content and how the students navigate the content (e.g. visited links), and also the interface. Adaptation must be seamless to the user but visible on request. This type of system would be useful for any form of training or educational course, covering material that is too technical for class/lectures or where additional

practice sessions are required. A nice feature would be some sort of adaptive testing and would show a student where their strengths and weaknesses lie.

### **B.2.3 Interview Code 00321 (WARWICK)**

The interview with the interviewee 00321 was conducted on 11<sup>th</sup> June 2008 in Coventry. The interviewee is a lecturer of computer science. The scenarios were understandable to her. The demonstration of the AHA! system was helpful in providing the interviewee with an idea of what an adaptive system is. The interviewee had a lot of experience with e-learning software. Furthermore, she used Sakai and Blackboard at the university in the context of a lecture, using communication tools among students and between students and training provider. The main benefit of using a learning system, she saw, is in the possibility for distance learning; teaching over greater distances, teaching both synchronously and asynchronously. An adaptive learning system for the interviewee appears especially suited for guided and individualized learning, reduction of learning space, orientation for project-based group learning and collaborative tasks guidance. Adaptation should be based on individual characteristics (i.e. interests, knowledge, learning/cognitive styles, preferences, background, activity level if in a group, individual reputation if in a group), group/social characteristics (i.e. group task, group goal, group achievement level, activity level, reputation, etc.), environment characteristics (i.e. machine type, quality of service, bandwidth, perceived bandwidth, etc.), content characteristics (i.e. content structure, links, etc.), provider goals (i.e. site provider goals, designer goals, etc.). She thinks links, content, position of items on the page (order, but also overall position), and the synchronization of items (pairing and general grouping of items) should be adapted.

### **B.2.4 Interview Code 06210 (VUB)**

Interviewee 06210 was a teacher, lecturer and author. This person has been a great proponent of technology-enhanced learning (TEL) environments for many years. This has made him very critical on this subject. One criticism, that arose even before the interview started, was the fact that the use of these environments can be 'suicidal' the teachers. There is not enough time for someone to provide all the content of a particular course. The university itself imposes this restriction. The focus is so much on having to create publications and perform other academic activities that the focus is taken away from the teaching activities.

The interviewee did not have the time to go over the demo scenario. After a short recapitulation of the scenarios, he could find some relevancy in both the professor viewpoint as well as the learner viewpoint. There were a lot of issues that are still not addressed in the current systems, which make it virtually impossible for the different stakeholder groups to efficiently use the learning/teaching environments. The experience of the interviewee tells him that students are still in favour of studying from books instead of the web. The reason for this is that from the perspective of the student, behind one link could be more than half of the course, so students need to click every link to see where on the website the content is. There are often too many links and all the content is not structured clearly. Therefore, the student gets tangled in this web of information. A nice feature, which could be added to adaptive learning environments, is that the students themselves should also have some part in specifying the adaptation. In fact, they should be able to create their own learning paths in a sense. So, the teacher enters the table of contents of a course into the system and the student can see this table and from every part in the course can select either 'theory', 'example', 'question', etc. When the student has done this, a personalized learning path will be constructed according to his/her preferences.

The implementation of such a system can be straightforward. However, finding the people to fill this system with the necessary information (the actual content) is a real problem. As soon as you are dealing with a number of different items in your course then, you have a number of different ways to explain these items and in addition, you need to create a number of different entry points to enter the course (with different backgrounds). This leads to an exponential problem in terms of the learning paths that one teacher has to create for a single course. The support for this creation of content is often lacking. Even if you succeed in creating all the content, there is the problem of maintenance. Suppose that this year you have to omit a small part of your course from last year. What happens then with all the learning paths that are using this particular part? The different relations between the parts of a course are enormous. Having an intuitive way of managing this information would enormously lower the threshold of using these systems. This environment has to be very easy to use so that the teacher can do it without intervention of specialists.

A final issue, mentioned as regards the creation of the content, is that this content needs to be specified in a form that can be processed in different ways within the learning environment. Information needs to be presented differently when someone chooses the 'theory-first'-approach than when he chooses the 'explain-by-example'-approach. An example presented in the first way has to be presented differently than it has to

be presented in the second way. It is also very important that teachers can import this information from other systems. If the university changes from system to system, or the teacher changes university, then all his data is not lost.

### **B.2.5 Interview Code 53003 (USI)**

This interview was done at the University of Lugano on 3<sup>rd</sup> June 2008. The interviewee was a training provider in the field of foreign language learning. She understood the scenario but found the AHA! English business course too simplified a model, but useful for a student who failed in a course and needs to recall some parts of the course. She found this approach useful in industry and continuing education programs, where the students have a strong motivation to study by themselves. She has used Moodle several times a week from 2005 and found almost no adaptation implemented within it. The main duties of a LMS are the support of logistical activities (e.g. calendar, online repository, sharing of materials, etc.) and a tool to support other media like CD-ROMs. The most important benefits are sharing and facilitating coordination, and the possibility of having a common place for retrieval of materials. She thought that the main limit in the field of language teaching, for an adaptive learning system, is the oral production (especially the dialogic form). The main adaptation criteria can be the goals and tasks of the user, their familiarity with the domain, their cognitive style and the learner's motivation; these can be reached if the system supports active learning, with an adaptation policy based mainly on the hiding and revealing of links between resources. The adaptation layer can be mainly at the content level in an automatic way and at the presentation level under the explicit influence of the user. She thought that the main adaptation dimensions are the sorting of information fragments, together with additional explanations and a high level of interactive and example-based problem solving support; adaptive testing would complete the user-based adaptation. The key for enabling such a system is the correct individuation of the granularity level of information that should act as a source for the adaptation and the user-friendliness of the whole system. She thinks that other domains that could benefit from an adaptive system are long life learning, or the health care field, for instance, training a user in medicine or for impaired people.

### **B.2.6 Interview Code 64004 (USI)**

This interview was done at the University of Applied Science of Southern Switzerland (SUPSI) in Manno on 10<sup>th</sup> June 2008 and the interviewee was a teacher in information technologies. He was familiar with the concepts expressed, and has used many different LMSs (Moodle, Blackboard, WebCT, etc.) on a daily basis for six years. In his opinion, the main weakness of this model was an unclear distinction between different skills, such as the content expert, the pedagogical expert, the tutor and the instructional designer. To him, the lack of a formal definition language for defining learning objectives was another limiting factor of this scenario. The main tasks achieved by the use of a LMS are the provision of a repository of teaching materials, a tool to foster the collaboration and the interaction between students and a stimulus for the creativity of the learner; its benefits are the re-usability of materials and of entire courses, the adaptation and updating of courses with a regular schedule, and the support and enhancement of student collaboration activities. He thinks that vocational training is the most suited field for its adoption. The main benefit of using this kind of system is mainly to help teachers cope with the heterogeneity of the students. The usability and user friendliness of the whole system are key. The main adaptation criteria are the goals and tasks of the user, their quickness and ability to acquire knowledge, their cognitive style together with their interests and motivation, and the adaptation to the user's current location. To him, the methodological approach is very important, so it is fundamental to adapt to the learning objectives but also to adapt to the user knowledge: this process should be done in both the content and (in particular) the presentation layers. This should be performed transparently to the user, and the user should be aware and in control of the whole process. He thinks that the main adaptation dimensions could be the prerequisite explanations combined with the different types of media used to present the contents; a direct guidance would allow a student to be independent in his/her study, the use of adaptive maps and resources recommended by peers or tutor would enable better understanding. A key point is the provision of some adaptive functionality into the interactive and example-based problem solving activities, and also as a supportive technology for the collaborative activities (both from the point of view of the learner and of the teacher, e.g. intelligent class monitoring).

### **B.2.7 Interview Code 79017 (UniGraz)**

The interview with the interviewee 79017 was conducted on 6<sup>th</sup> June 2008 in Graz. The interviewee is a university assistant. As the interviewee had already some background knowledge about LMSs and adaptivity the scenario document was clearly understandable to the interviewee, and the introductory definition and demonstration of an adaptive system could be kept short. The scenarios were judged as being relevant for

the interviewee; she felt familiar with the described situations as she had been using LMSs and has even tried out an adaptive system in learner as well as teacher roles. Referring to the demo scenario, she pointed out that she could also imagine the preparation of adaptive courses for larger, rather anonymous audiences of learners. The interviewee has experience with several learning systems, especially Moodle and Ilias and has used them for the creation of courses and organization of learning content several times a week. The ALEKS system, which she has also tried out, provides adaptivity to learner knowledge. The main benefits in using LMSs, she saw, were the automatic overview, organization, and re-usability of learning material. Contents can easily be added, modified, and re-organized. She judges an adaptive system especially suited for teaching learners of differing knowledge levels and learning achievement, and for taking into account differing learning styles. The main benefit of an adaptive learning system is the tailoring of the learning environment and contents to the individual. She thought adaptation should be done according to the learning achievement and prior knowledge of the learner, and eventually to learner's age and gender, as well as learning style and preferences. Adaptation criteria judged as being the most important were learning goal, learner knowledge, and motivation. According to the interviewee, adaptation should be realized on the level of the learning content, i.e. the presentation, the sequence, and the amount of content presented. Furthermore, adaptation should be done with respect to the navigation through the learning system. Another aspect that needs adaptation is the level of self-regulation, i.e. how much the learner can interfere with the learning system. Adaptation dimensions judged as being critical were adaptive selection of learning content and learning activities, adaptive assessment, and specific types of navigation support (map annotation and adaptive link generation). Most essential in an adaptive learning system is the adaptation of learning content in a way that the learner is neither over- nor under-challenged. Adaptation to the learning style should be done at a global level. In the interviewee's opinion adaptivity should not be overdone, i.e. realized in many different ways. Rather, few but clearly targeted aspects of adaptation should be implemented. The user should furthermore have the possibility to get an insight into the adaptation process and its underlying principles. A further application area for adaptive systems, she saw, was in the field of dyslexia training, as in this field highly individualized training is necessary. In general, the interviewee argued that the importance ratings were quite difficult for her to do; she always tried to compare to prior ratings and judge whether the current aspect is more or less important. As an alternative way of rating the importance she suggested to request an order of importance.

### **B.2.8 Interview Code 00623 (TUE)**

The interview with the interviewee 00623 was conducted on 30<sup>th</sup> May 2008 in Eindhoven. The interviewee was a training provider (author and teacher) in the Eindhoven University of Technology (TU/e). The scenario was found to be highly relevant by the interviewee. The tutor's/author's role was found to be closest to his own. However, the interviewee does not have experience in designing an adaptive course. From the point of view of the author, the following is the main advantage of using learning systems: the author needs just to create learning material and insert it into the course, the system will automatically generate everything else for the author. However, the interviewee noticed that the author should take into account a lot of contexts during designing the learning material for (adaptive) learning system and spend more time on it. Another highlighted advantage of using an adaptive LMS is the re-use of learning material, but, again, the author in this case should specify the context for which the system is meant. There is also a necessity of keeping the book paradigm while designing the adaptive course, so that the student could return back to the learning materials previously studied. Finally, it is necessary to provide help and guidance while taking adaptive courses. It is important that the student is not exposed to the adaptivity.

### **B.2.9 Interview Code 07011 (TUE)**

The interview with the interviewee 07011 was conducted on 12<sup>th</sup> June 2008 at University of Jyväskylä, Finland. The interviewee was a training provider (author and teacher) at University of Jyväskylä. The interviewee had experience in using LMSs in the learning process. However, she did not have any experience in using adaptive learning systems. The interviewee liked the scenario and found it clear and reasonable. There was a discussion about the different roles described in the scenario (student, author, and tutor) and corresponding functionality of the adaptive learning system. The roles of an author and a tutor were found to be closest to her own role. She said that she would be interested in the development of this type of system. Besides learning material re-use and distant access, the interviewee mentioned the possibility of storing students' assignments as one of the advantages of learning systems. The interviewee highlighted the importance of personalization of the learning materials to the individual learning styles, learning strategies and prior knowledge of the students. The interviewee marked out the following important functionality that should be supported by an adaptive learning system: good support for the authors, tutors and the students; the possibility of customizing the level of adaptation; and easy access to the system.

### **B.2.10 Interview Code 73072 (OUNL)**

The interview with the interviewee 73072 took place on 26<sup>th</sup> May 2008 in Heerlen. The interviewee was an assistant professor at OUNL. Her main job is research, but she also guides PhD students and teaches remotely at another university. She was well informed about adaptive learning systems and did some research in this field. The interviewee thought that the use cases were short, vague, and not attractive enough; they provided just basic descriptions. As the descriptions were abstract, the benefits were not entirely clear. For her, the tutor and author scenarios were highly relevant, although the authoring use case does not say anything about the complexity of the process if adaptive learning is the aim. In the past she has used the learning systems Educativa and Blackboard. Presently, she uses Moodle. During term-time, she uses the system everyday. Altogether, she has used learning systems for 14 years - both as student and teacher. She uses the learning system for learning, teaching, guiding, and research. According to her the benefits are interaction with remote people, knowledge sharing, collaboration groups, student assessment, and students' opportunity to create and share content. The interviewee thinks that adaptive learning systems are suited for the provision of different learning paths for various learners. According to her, learners can benefit from a personalized learning trajectory, tutors from better support for students, and authors from production of content fitting better to the students' needs. Prior knowledge and learning goal she considers as important sources of adaptation for learners, together with learner's interests and their platform. For authors, the system can also recommend resources based on the topic and the target group. She considers learning styles to be an unreliable source of adaptation, as it depends on the context. According to her, the learner should control the adaptation - learning path supported by recommendations, content and adaptation strategy, etc. She mentions informal professional learning and social help support as other application areas. The interview lasted approximately 85 minutes.

### **B.2.11 Interview Code 67031 (OUNL)**

The interview with the interviewee 67031 was conducted on 27<sup>th</sup> May 2008 in Heerlen. The interviewee was a professor at OUNL. His job includes mentoring of PhD students. He is very familiar with the field of personalized adaptive learning. He found the learner and tutor scenarios highly relevant and the authoring scenario partially relevant, mentioning a difficulty with distinguishing the author and tutor roles. Currently, he uses Moodle once per week, but in the past he has used learning systems for 15 years. They have provided adaptive annotations, sequencing, recommendations, content selection and presentation, as well as learning strategy selection. He uses learning systems for supervising courses and project cooperation. The benefits he sees are the automatic support of academic features, technical features relevant for education, and the structuring metaphor (i.e. a time schedule). According to him adaptive learning systems are best suited for adaptive knowledge testing, usage in fast changing domains, keeping track of learning achievements, and recommending new learning paths. The benefits are in learning efficiency, understanding, ease of use, and motivation. As sources of adaptation he expects competences, knowledge level, preferences, interests, peer group, physical location, delivery device, context, learning objectives, and time constraints to feature. He thinks the task list should be adapted to the agenda and higher-level goals, recommendations to interests and current activity, and content difficulty to the perceived ability of the learner. For the interviewee, essential features are monitoring facilities, guidance, and recommendation - they all should be presented via a flexibly configurable personal learning environment, for example, utilizing Web 2.0 technologies. Other application areas are professional training, knowledge management, schools, and informal learning. The interview lasted approximately 60 minutes.

### **B.2.12 Interview Code 74031 (OUNL)**

The interview with the interviewee 74031 was conducted on 12<sup>th</sup> June 2008 in Liege. The interviewee was a university assistant in charge of mandatory and optional Dutch language learning programs. The interviewee was a teacher/tutor and an instructional designer, delivering and providing extra learning material to pupils via WebCT. The introductory definition and demonstration of an adaptive system could be kept short since the interviewee had already some background knowledge about aspects of adaptivity. Though the interviewee found the scenario document clearly understandable and highly relevant, she thinks that the scenarios pre-suppose many resources in time and workforce, which is not the case in her institution. With approximately three to four hundred students, no one in her team can practice close personalization. Differentiation takes place at a group level. She has, for example, set up on WebCT an automatic feedback system regarding the most common grammatical mistakes. She mentions also that the WebCT tool 'Voice board', creates a one-to-one teacher/student private learning space. Using 'Tell Me More', students can learn at their own pace. However, for the activities on WebCT, the time frame is the same for all students in order to allow the creation of discussion forums based on common readings. Learning styles are not a guiding idea when the interviewee develops learning objects but a variety of the offered resources are. And she, of

course, takes account of prior knowledge (provided by an initial test which sorts students in ability level A, B or C). Occasionally, and only on demand of individuals, she tries to personalize learning material based on interest. Though she deplores the lack of resource localization possibilities, the absence of interaction with peers and teacher and the narrow drill and practice orientation in 'Tell Me More', she is envious of its dashboard which allows teacher/student to see all available activities and resources and which displays clear indicators about their level of completion. She would like to rely on a similar comprehensive view with the material she develops on her own. The benefits of using a learning system are visualization facilities, the ability to communicate effectively with students, and tracking facilities. Adaptation criteria judged as being the most important included learning goal/tasks, learner interests, language and platform. According to the interviewee, adaptation should be realized on the level of additional information, interactive problem solving support, example-based problem solving, and adaptive assessment/testing/questions. However, the interviewee considers that her ratings must be treated with caution because she has not necessarily figured out the details involved with each of them.

### **B.2.13 Interview Code 57016 (OUNL)**

The interview with the interviewee 57016 was conducted on 2<sup>nd</sup> June 2008 in Heerlen. The interviewee was a teacher and researcher at OUNL. According to him, the scenarios do not indicate which issues have been already solved. For OUNL students, the scenario is more relevant than for normal university students. For him the learner scenario is non-relevant, but the tutor and author scenarios are highly relevant. The interviewee uses the Blackboard system a few times a week. He has used learning systems for 25 years but without any personalization or adaptive features. He uses it for information offering and as a portfolio where students can upload their products. The benefits are the provision of up-to-date course content and the possibility of getting feedback. He thinks an adaptive learning system can provide alternative learning paths based on different starting points and background knowledge, based on the context and intention. The benefits for the learner are efficient learning and improved motivation. For the other two roles, there are indirect added values. According to the interviewee, a learning system should adapt to prior knowledge and current intention (goals and tasks). He thinks the content (presentation, ordering, and selection) and the teaching strategy should be adapted. He considers an overview of students' performance, adaptation to students' intentions, and templates for authors and tutors as essential functionality for an adaptive learning system. He sees distance education, learning networks, training of skills, and competence development as possible application areas. Finally, he considers the problem to be unresolved since research data is lacking. The interview lasted approximately 100 minutes.

### **B.2.14 Interview Code 58018 (OUNL)**

The interview with the interviewee 58018 was conducted on 3<sup>rd</sup> June 2008 in Heerlen. The interviewee is a tutor of distance learning courses and an author of learning materials at OUNL. For her, the scenarios were clear, but do not reflect her practice with distance education, which is without any adaptivity. From a tutor perspective, she considers monitoring of learner's progress important. All three scenarios were partially relevant for her. She uses the Blackboard learning system, but also FrontPage for authoring, Drupal, a wiki, and a blog. She uses them regularly for the past ten years. Her learning systems provide some adaptive features, but they use them in a limited way - e.g. notification according to user profile (using MySpace), adaptability, notification of tutors regarding the discussion forum, etc. She uses learning systems for flexible delivery of content, communication with students, and progress monitoring. Regarding the benefits, she says that in distance learning a LMS is essential - new forms of communication and a more efficient development process. According to her an adaptive learning system is suited to more efficient learning providing a limited amount of material to a student, recommendation of successful learning paths, and monitoring of learning progress. The main benefits she sees include notification and monitoring. As sources of adaptation, she would expect student's background, prior knowledge and preferences (e.g. language). She thinks that content and instruction should be adapted (fixed basics and flexible parts), which should be done by different presentations, considering the quantity of text and modality. For the interviewee, the essential functionality is notification (instead of a changing environment), non-obtrusive forms of adaptation and suggestion. The interview lasted approximately 100 minutes.

### **B.2.15 Interview Code 64002 (OUNL)**

The interview with the interviewee 64002 took place on 5<sup>th</sup> June 2008 in Heerlen. The interviewee was a teacher in distance education at OUNL. He thought the scenarios were clear. From the learner's perspective, a personal learning goal has to fit into the curriculum and there should be room for surprise and discovery. Students can also author materials, but a quality check is needed. For tutors it is difficult to get relevant

information on students. He has raised the issue of freedom versus control of tutors, which can be addressed via peer reviewing and reflection. The learner and tutor scenarios were highly relevant for him, in particular the authoring role. He uses the Blackboard LMS, but also a special examination system, course evaluation system, progress monitoring system and email. He uses these on a daily or weekly basis for the past year. He does not use any adaptive features. The purpose is to give assignments to students, to provide learning content, communication, and collaboration. According to him the benefits include correcting his own errors, communication with students, logistical benefits, and monitoring of learning activities. The interviewee thinks an adaptive learning system provides temporal and content flexibility and the identification of weaknesses and strengths. According to him, a learning system should adapt to the student performance, preferences, goals, wishes, considering also user role and location. Content (student and teacher as designers, teacher as approval), pace (according to progress, time, place) and task (contextualization and personalization) should be adapted. He considered the essential functionality to be the automatic planning of tasks (supported by visualizations) and progress monitoring (shared and controlled). He can also imagine other application areas, for instance education for special groups (disabled people) and the management of learners in learning networks. Finally, he thinks that personalization has to meet certain standards in learning assessment. The interview lasted approximately 90 minutes.

### **B.3 Other Profile**

#### **B.3.1 Interview Code 77132 (OUNL) (research assistant)**

The interview with the interviewee 77132 took place on 9<sup>th</sup> June 2008 in Heerlen. The interviewee was a PhD student at OUNL. He was very familiar with adaptive learning systems as this is his area of research. He had not read the demo scenario. He uses learning systems, namely Moodle and Drupal, approximately every two days for the past three years. The systems do not provide any adaptation features. He uses them for university study and sees their benefits in interactive tests, integration of multimedia, communication, and sharing of digital materials. According to him, adaptive learning systems are useful for recommending learning materials, different media, and supporting learning groups. Other uses include the adaptation of content to prior knowledge and adaptation to changing curricula. The main benefits are effectiveness and efficiency of study, learner's satisfaction, and reduced drop out rates. The interviewee expects the following sources of adaptation: prior knowledge, learning goal, interest, motivation, and study time. He thinks curricula should be adapted via adjustment of learning activities and time schedule, then media type according to current preferences. The course should be adapted to the learner's preferences (including language), needs, competences, study time, and hardware device. For him the essential functionalities are the recommendation of interesting materials, explanation and control of adaptation, recommendation of peer learners, a question answering tool (from a peer learner or tutor), as well as the ability to rate and tag learning materials. As application areas, he proposes informal learning, open educational resources, and knowledge management systems. The interview (without discussing the demo scenario) lasted approximately 40 minutes.

#### **B.3.2 Interview Code 64042 (OUNL) (research/developer)**

The interview with the interviewee 64042 took place on 9<sup>th</sup> June 2008 in Heerlen. The interviewee was an educational technologist at OUNL. She was familiar with adaptive learning systems as her research is related to this area. She had read the demo scenario and thinks that the motivation to adapt learning could be clearer and asks whether different environments are necessary, as the roles can overlap. All three scenarios are highly relevant for her at the conceptual level. She uses the Blackboard and Moodle learning systems; the former twice a week, the latter once a month. She has been using learning systems for the past eight years. The systems she used provided adaptive learning paths and an adaptive interface. The interviewee uses the learning systems for learner's guidance, self-tests, and general information to perform the study tasks, collaborative tasks, and student portfolios. Adaptive learning systems can generate personalized learning paths and content, but she is sceptical as regards learning styles and how to respond to them. She sees the benefits of adaptive learning systems as being improved efficiency and enhanced motivation for learners. The interviewee considers the following characteristics as sources of adaptation: student performance and preferences. She thinks the learning path and content (presentation) can be adapted according to past performance and prior knowledge. For her, the essential functionality of an adaptive learning system includes learner path and content adaptation, an overview of the learner's progress and state in the domain based on assessment. Adaptive assessment should be presented with clear feedback. Adaptivity should be transparent to the learner. With respect to application areas, she mentions



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workplace learning with shared learning paths and informal learning. The interview lasted approximately 75 minutes.