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Executive Summary

In this internal deliverable we report about the evaluation of the Graphical PDP Planning Tool. The GPT is intended for visually supporting learners in the creation of personal learning plans. We carried out a user study to evaluate its functionality and usability. The scenario was focused on a competence profile around "learning how to drive". The findings were generally positive (participants found quite easy the use of the tool, they found that the tool facilitates the planning task, etc.), despite some problems learners had. Based on the results, a new graphical design is introduced.

1 Graphical PDP Planning Tool (GPT)

In this chapter we describe the Graphical PDP Planning Tool (GPT), which is the result of several iterations, some of which have been described in D7.1 and D7.2. The GPT is intended for visually supporting learners in the creation of personal learning plans. The approach combines the usage of the concept mapping method, the bubble metaphor, the tooltip graphical user interface element, and the computations provided by the Hybrid Personalizer (see D7.2).

The Graphical PDP Planning Tool enables users to graphically explore existing learning paths organized according to their goals and preferences and to create their personal plans (PDPs). In section 1.1 we present the first design of the GPT. In section 1.2 we discuss the preliminary evaluation. The findings resulting from the user study show that we should continue working in the proposed direction, but that we should make more iterations in the design and evaluation of the tool. The current version of the GPT, in which the findings from the evaluation have been incorporated, is presented in section 1.3, along with the integration of the GPT with the PDP Planning Tool and the Hybrid Personalizer.

The integration of this graphical approach in the TENCompetence infrastructure will provide us with interesting opportunities to evaluate the tool in authentic lifelong learning scenarios for competence development.

1.1 First design of the Graphical Planning Tool

An important research line in the educational technologies field is devoted to support teachers when planning learning processes [5]. Some researchers have also recognized the need of providing solutions that enable learners to inspect and reflect on the learning plans designed by experts (typically teachers) [2, 11]. However, there are not many efforts explicitly considering the role of the learners in the creation of their own learning paths. This support is especially relevant in lifelong learning scenarios where learners have different backgrounds, motivations or experiences [13] and should not be forced to follow a learning path that does not suit their specific learning needs, hinders their competence development or limits their cognitive abilities [11].

A Personal Development Plan (PDP) is defined in [12] as "a structured and supported process undertaken by an individual to reflect upon their own learning, performance and/or achievement and to plan for their personal, educational, and career development." Moreover, [14] identifies the potential benefits of PDPs in terms of: enhanced learner motivation and confidence; greater sense of ownership of the learning process; improved decision-making skills; and clear progression paths.

Some authors propose the use of Mindtool approaches when learning plans are combined with online learning environments that imply learner thinking [2]. Mindtools are applications used by learners to represent their knowledge in concept maps. This engages them in critical thinking about the content they are studying [9]. Concept mapping is a process by which learners represent their understanding of a specific knowledge domain in a graphical way, using nodes to represent ideas and links to represent the relationships that connect ideas. The result is a map or a graph that visually represents the way in which a learner organizes a set of related concepts or ideas [1, 4].

In this section we borrow the main ideas of concept mapping to facilitate the potential benefits of PDPs by proposing and preliminary evaluating a visual authoring tool (a planner) for learners to explore existing learning paths and to plan and create their own PDP. The first experiments conducted in the TENCompetence project have shown that using the concept of PDPs (learners were able to create and reflect on their PDPs, though not visually) had positive effects such as:
- learners feeling in control in their own learning;
- learners feeling that they learn exactly what the want;
- learners have insight into how their learning progress [13].

1.1.1 Existing approaches

The design and use of interactive information visualization tools, such as e-learning editors, have been widely studied in the past. As advised by (Schneiderman et al, 2000) visual tools should be designed to be both, displays and search tools at the same time.

Some visual schemes generate only one view per information space, but allow the user to zoom in and out, rotate, or, in general, change her viewpoint on the visualization. The approach to visualize information spaces often makes it difficult for users to isolate, identify, and analyze parts or aspects of the information space. Users should be allowed to customize and control how the tool at hand addresses information spaces. Moreover, users should be able to specify which part of the information space is visualized in a dynamic manner. Therefore, making browsing or re-querying information spaces a process of switching between different views and viewpoints. The latter approach is not only based on the fact that tools should allow free browsing, but also on the general need of users to identify relations within the information space and between information spaces as well.

The efficiency of tools is derived from the ability of humans to assimilate to them and to work efficiently with them. With tailoring these applications and schemes to the user taking into account the human cognitive process and, at the same time, its limitations and powers, designers can maximize the tool's utility. A visualization that overwhelms human sensors will only frustrate its users. Consequently, users will become largely prompt to erroneous behavior and discontinuity with the information's context. The failure to take human physiological properties into consideration may be the explanation behind the failure of many complex information schemes in achieving high usability levels.

1.1.2 A first graphical approach

After several iterations regarding the prototype of the graphical approach, we designed the visualization tool shown in Figure 5 by adopting the approach of concept mapping [1, 4] and the "bubble" metaphor [6]. Bubble-based interfaces enable the flexible and user-friendly visualization of abstract information as nodes in a map relying on colour cues based on categories, importance, or urgency; thus making navigation easier [6]. In our case, bubbles represent competences and learning activities or courses building up a learning path.

The interface is organized in three main areas. The area situated at the top of the interface contains the competences related to a competence profile (set of competences that define the requirements for achieving a learning goal). Each competence is visualized as a bubble with a different colour depending on the topic area (see Figure 5, a). If a learner puts the mouse over a competence, the bubble and the learning activities or courses that facilitate the development of this competence are highlighted (see Figure 5, e).
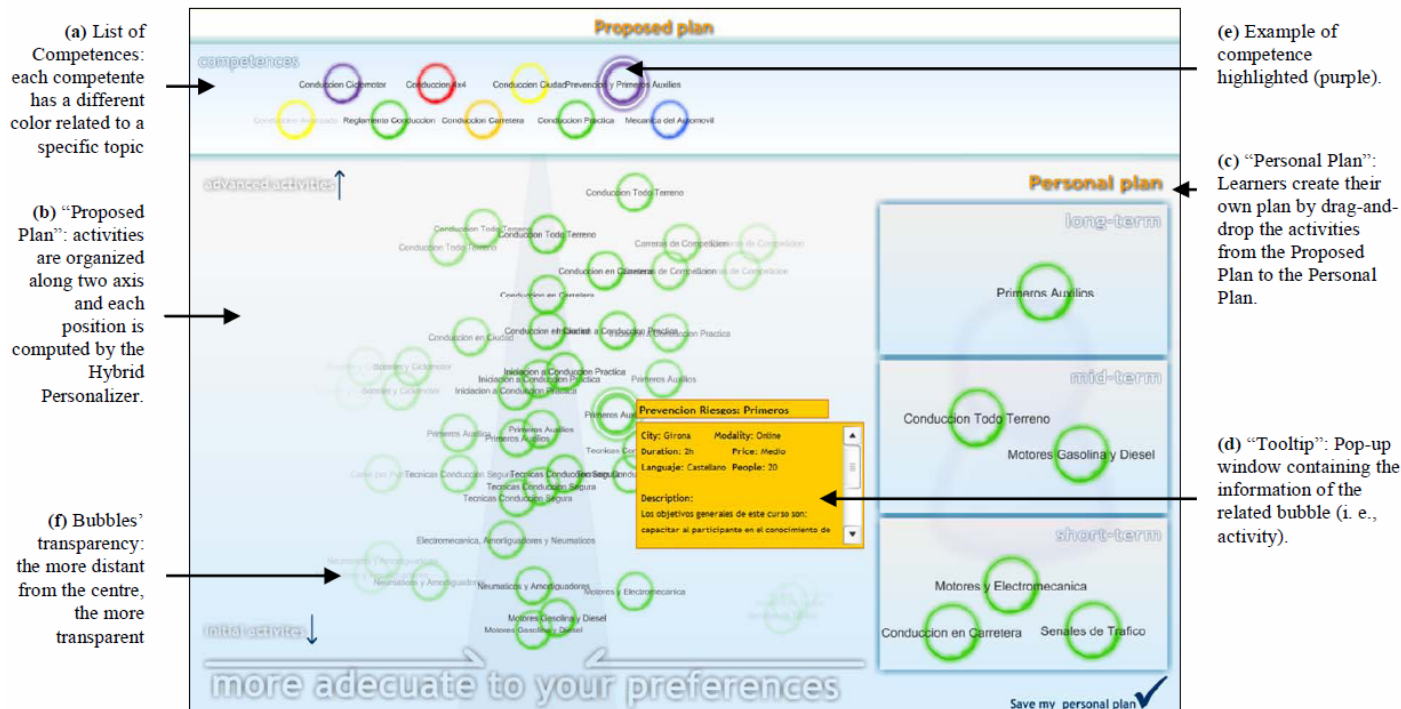
Figure 5: Screenshot of the tool for the graphical creation of PDPs

The activities and courses (that build the information space referred to before) are situated in the main area of the interface (Figure 5, b). These bubbles are organized in a way that provides recommendations of learning paths (proposed plan). The proposed plan is calculated using a service developed within the TENCompetence project called the Hybrid Personalizer [8]. It computes each bubble's position taking into account

1. the learning goals;
2. other learner's behaviour in a similar situation;
3. the preferences of a learner and, as a result.

It suggests the learner a possible path (central darker area in form of a triangle, Figure 5) which can be followed in order to acquire a specific competence profile. The path is organized among two axis: a vertical axis which is a "temporal line" based on the activities' relations, and a horizontal axis which takes into account the learner's preferences.

That is, bottom and top of the vertical axis represent "initial activities" and "advanced or later activities", respectively; and, with the horizontal axis, we specify the position of the bubbles more suitable to the learner's preferences and situation (derived from other learner's behaviour). In addition, each bubble has an alpha level (transparency) which depends on how close the learning activity is to the centre of the proposed plan area: the closer the learning activities are to the centre, the less transparent they are (Figure 5, f). This main area of the interface (Figure 5, b) can be used for exploring the suggested learning activities or courses. Each bubble has associated a "tooltip" (a small window that pops-up when a user clicks on the bubble, see Figure 5, d) where learners can find the details of the learning activity (see Figure 5, d).

In the right area of the interface, learners can create their own personal plan by dragging and dropping the bubbles from the proposed plan area to this area. The personal plan area is split in three sections according to the time when the learner will perform the chosen learning activities. More specifically, these sections are labelled as short term, middle term and long term (see Figure 5, c).

1.2 Evaluation of the Graphical Planning Tool

With the aim of obtaining the first evaluation results of our approach we conducted a preliminary user study [16]. The main questions of interest were:
1. Do users realize the purpose of the tool and use it properly?
2. Do users understand what is shown in the interface?
3. Which changes and additions will improve the usability of the tool?

1.2.1 Description of the user study

The scenario was focused on a competence profile around "learning how to drive". It was realistic and complex enough in the sense that the profile comprised seven different competences, and a total of 50 activities or courses shaped the proposed learning paths shown by the tool.

We defined two potential "user profiles" (a "farmer" and an "executive") for a predefined suggestion offered by the tool. Both user profiles had the same learning goal (driving) and shared the some preferences (practical activities, location of the courses and language). The predefined suggestion took into account these common preferences (according to the algorithms of the Hybrid Personalizer). This suggestion was therefore the same for both user profiles (see Figure 5). However, each user profile had additional preferences not considered by the tool: the "farmer" required cheap courses and was only aiming at being able to drive within the farm (no need for an official license); the busy "executive" was interested in short courses with a low number of participants, aimed at the driving license and had already attended some related theoretical lessons in the past. Using the predefined suggestion as a starting point together with the interactive functionalities of the tool, the users (adopting one of the profiles) were expected to flexibly create the development plans most appropriate to their profile. For each profile, we classified each activity or course into the following four categories: expected (in the most appropriate plan according to all the preferences), may be expected, might be expected and unexpected. Table 2 summarizes the different data sources considered in the evaluation.

Data Source	Type of Data	Labels
Final Questionnaire	Quantitative ratings and qualitative opinions, 14 different participants	[Quest-all] [Quest-farmerX] [Quest-executiveX] Where X is the number of the user, from 1 to 7
Observations during the pilot	Record of direct observations during the experience by 2 different researchers.	[Observer1] [Observer2]
Differences between the expected and created plans	Quantitative data measuring the number and type of differences between the expected plan and the final outcomes of the users.	[diff-farmerX] [diff-executiveX] Where X is the number of the user, from 1 to 7

Table 2: Data sources for the evaluation

14 users participated in the study; each of them used the tool for the first time. We randomly assigned the "farmer" profile to half of them and the "executive" profile to the other half. After a brief explanation of 5 minutes, users read the description of their assigned profiles and used the tool to create personal plans. It took them 40 minutes in average.

Two researchers were recording observations on how the participants used the tools, any incidents or emerging comments. The resulting plans were collected to evaluate the differences between the expected and the actually created plans. Finally, a test with closed and open questions about the experience was completed by the participants. Due to the characteristics of the user study, we followed a mixed evaluation method [3] combining and triangulating [7] the qualitative and quantitative data

obtained from the different sources listed in Table 1. The quantitative data was considered useful for showing tendencies. The qualitative results, in contrast, were used to confirm or reject those tendencies, to understand them and to identify emergent outcomes.

1.2.2 Results and Discussion

Table 3 shows the differences between the expected and the created plans of each user according to the measures explained in the previous section. Table 4 summarizes the results related to each question of interest for evaluation. Some of the results are discussed in more detail in this section.

	Farmer				Executive			
	++	+	-	--	++	+	-	--
1	10	0	0	3	8	0	1	3
2	8	2	0	2	9	1	1	1
3	8	3	0	1	8	1	0	5
4	7	1	0	4	3	3	3	3
5	5	4	1	2	6	3	0	5
6	8	3	0	1	6	1	0	8
7	6	3	0	3	7	0	0	11

Table 3: Differences between the expected and the created plans (++ expected, + may be expected, - might be expected, -- unexpected)

Questions	Results
1) Do users realize the purpose of the tool and use it properly?	• After some initial minutes of familiarization, the majority of the participants understood the purpose of the tool and the experiment. However, more time devoted for familiarization with the tool would have been helpful. • The users found the tool flexible enough for planning their learning paths, and were able to create learning plans that were close to the expected ones. Many of the unexpected selections were due to misunderstandings about the name of the activities (and not to the tool itself). • Most participants found the interaction with the interface quite easy. They were also fairly satisfied with using the tool. • Most participants would recommend the tool to others because they think the tool facilitates the planning task.
2) Do users understand what is shown in the interface?	• Almost half of the users understood the precise meaning of the x-axis. From the rest, some (3) did not find out any meaning or others (3) did not realize the meaning of the axes or that the axes had different meanings. • The majority of the users understood the meaning of the Y axis, however the specific understanding was diverse and only in a few cases it was as intended. Only two users did not realize that the axis had a meaning. • At least one user did not understand the organization of the "personal plan area".
3) Which changes and additions will improve the usability of the tool?	• Visualizing all the activities in one page to provide a complete overview and avoid the use of the scrollbar. • A garbage bin for deleting the unwished activities. • Enabling to move away the bubbles without them slipping back to the original place. • When selecting a competence, highlight the activities related to it with the same colour. • Spreading, hiding or keeping the bubbles as a background in order to avoid the overlap between bubbles. Careful use of transparencies. • Improving the tool-tip's management.

Table 4: Questions of interest and main results achieved in the user study

Regarding the 1) question (see Table 4) we can say that most users understood the aim of the tool and found it flexible enough for planning and creating their learning paths. In fact, despite the limited time devoted to familiarization and the unexpected selections done by users (many of those due to misunderstandings about the name of the activities – selection of activities with similar names in case they embrace different content or not selection of activities because they can have overlapping topics- and not to the tool itself), 85% of participants choose more than a half of the activities we expected [diff-all], with no significant difference between [diff-farmers] and [diffexecutives]. Moreover, 69% of the participants rated the interaction with the interface higher than 4 (in a range of 0 –difficult– to 6 – easy–). 78% of the participants would recommend the tool to others because they think the tool facilitates the planning task [Quest-all]. Several persons indicated *"It is a quite good graphical tool and it can help people to plan in this kind of situations"* [Quest-executive2]; *"The interface facilitates the task and the organization of the information is logical"* [Quest-farmer3].

With regard to the understanding of the interface (question 2), the results are globally positive (57% understood the precise meaning of the X axis [Questall], they also explained *"It computes suitable courses"* [Quest-executive5]", *"The position of the activities depends on whether they are more or less suitable to your profile"* [Quest-farmer3]; and the majority had an idea of the connotation of the Y axis, as they said *"It classifies the activities in initial and advanced* [Quest-farmer1-farmer6-executive3-executive4]", *"From more general to specific* [Quest-executive1]", *"From less to more difficulty* [Quest-executive2]").

However, more efforts should be devoted towards a more precise understanding of the recommendations along the Y axis and highlighting the role of the X axis. For example, Executive7 did not understand any of the axis as it was seen in the answers provided in [Quest-executive7]. This issue also justifies his/her unexpected selections [diffexecutive7]. These efforts should also consider solutions for those circumstances in which much information needs to be visualized. Though its organization is appreciated by the users, sometimes the overlapping of elements (bubbles) hinders a satisfactory use of the tool. As some participants mentioned *"Too much information, and sometimes overlapped* [Quest-farmer2]", *"Some bubbles were too close…* [Quest-executive2]".

Another result related to the changes that could improve the usability of the tool (question 3) emerged from the common opinion of the participants [Quest-all] of avoiding the use of the scrollbar and providing always a complete overview of the information space. A garbage bin for deleting the unwished bubbles or enabling users to move away the bubbles without them slipping back to their original place were among the suggestions [Quest-all]. Besides that, most users expected that selecting a competence results in the related activities appearing in the same colour [Quest-all]. [Observer1] also supported this result by indicating *"After clicking on each competence, students expected that the bubbles related to this competence kept highlighted using the same colour."* Users also stressed the necessity of improving the management of tooltips. For example, [Quest-executive4] mentioned *"Sometimes it's difficult to keep control over the tooltips because you don't know which tooltip belongs to which activity."* This result is also supported by [Observer2]: *"Some students opened the tooltips (by clicking on the bubbles) but they did not know how to close them."*

1.3 The enhanced visual tool

In the previous section we described a study carried out for analysing the understanding of the tool's purpose, the suitability of the graphic elements shown in the interface, and the changes or additions that would improve the usability and functionality of the tool. The findings were generally positive (participants found quite easy the use of the tool, they found that the tool facilitates the planning task, etc.), despite some problems learners had (using the scrollbar for seeing all the information, not being able to delete activities, difficulties for discerning the activities related to a competence, etc). This represents a step forward for better satisfying the learners' needs in the creation of PDPs.

Table 5 summarizes the solutions for improving the tool's usability according to the most important findings of the user study presented in the previous section.

Problem in GPT 1.0	Solution in GPT 2.0	Label
Using of the scrollbar for seeing all the information of the interface.	Visualizing all the information in one page by resizing the tool according the browser's window.	[sol1]
Difficulties for discerning the activities related to a competence.	Doing a click on a competence, the activities related to it keep highlighted with the same color.	[sol2]
Bubbles come back at the original place every time the learner drops them.	Enabling to move away the bubbles without having to come back at the original place.	[sol3]
Difficulties in closing the tool-tips (by doing a click on the related activity).	Adding a cross button to each tooltip for closing it.	[sol4]
Difficulties for understanding the "long-mid-short term" areas.	Adding a calendar for having and overview of the planned activities.	[sol5]
The unwished activities cannot be deleted.	Including a garbage bin for dropping the unwished activities.	[sol6]

Table 5: Changes (derived from the user study) that improve the usability of the GPT 1.0

In this section we introduce the new graphical design, based on the results of the preliminary evaluation. Further, we discuss how the GPT has been integrated with the PDP Planning Tool and how both tools now benefit from the personalization support of the Hybrid Personalizer.

1.3.1 New Graphical Design

The interface, organized in four areas, shows all the information in one screen, avoiding the use of the scrollbar [sol1]. At the top, there is a list containing the competences related to a competence profile. Depending on the topic area, each competence has a different colour (see Figure 6a), and doing a click on a competence, the activities related to it change into the same colour of the competence (see Figure 6) [sol2].

The learning activities are situated in the main area of the interface (Figure 6b). This area contain the personal plan computed using the Hybrid Personalizer (see section 4.3.3). It suggests the learner a possible path which can be followed in order to acquire a specific competence profile. The path is organized among a vertical axis based on the activities' relations, and a horizontal axis which takes into account the learner's preferences and the behaviour of other learners. The main area (Figure 6b) can be used for exploring the suggested learning activities by dragging and dropping each bubble wherever the learner wants [sol3]. Each bubble has again associated a tooltip where learners can find a description of the learning activity. Further, the learner can specify the start and end dates determining when they have planned to do the specific activity. For closing each tooltip, the learner can click on the red-cross [sol4].

A calendar, located at the top-right area (see Figure 6d), contains an overview of the planned activities [sol5]. Doing a click on a dark-blue coloured day, a tooltip shows the information of the planned activities for that day (see Figure 6e). Besides that, in the bottom-right area, there is a garbage bin (see Figure 6f) which contains the learner's unwished bubbles [sol6].
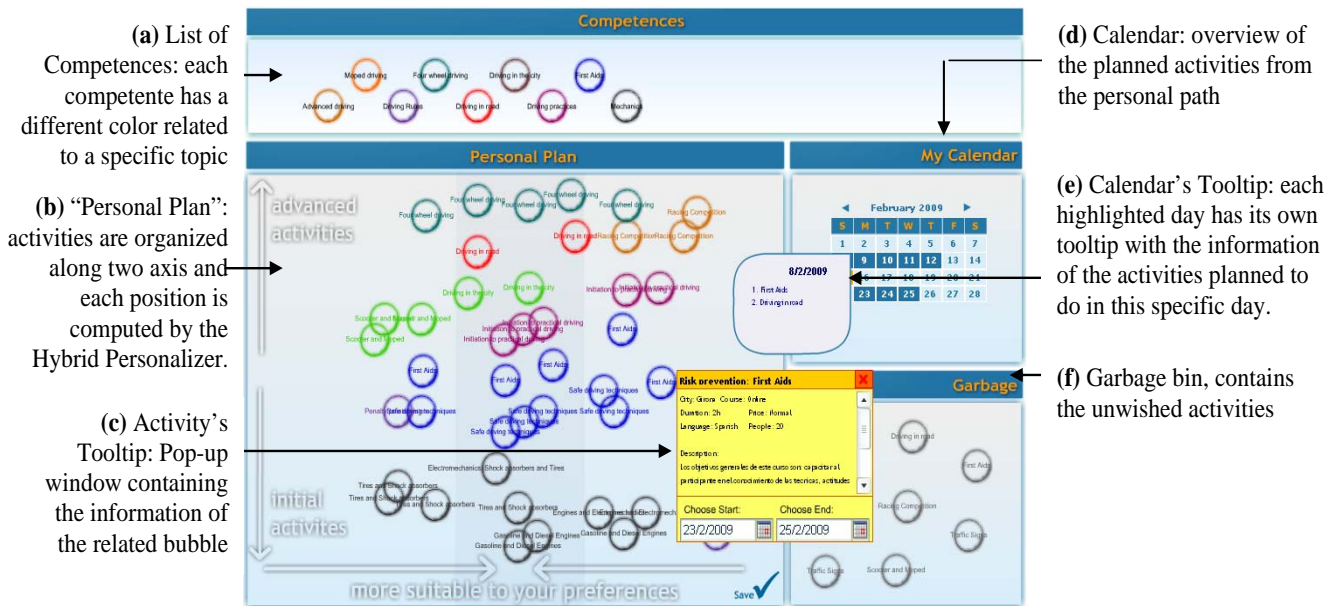
(a) List of Competences: each competente has a different color related to a specific topic

(b) "Personal Plan": activities are organized along two axis and each position is computed by the Hybrid Personalizer.

(c) Activity's Tooltip: Pop-up window containing the information of the related bubble

(d) Calendar: overview of the planned activities from the personal path

(e) Calendar's Tooltip: each highlighted day has its own tooltip with the information of the activities planned to do in this specific day.

(f) Garbage bin, contains the unwished activities

Figure 6: Screenshot of the enhanced tool for the graphical creation of PDPs

1.3.2 Integration of the GPT with the PDP Tool

The PDP Tool (a more detailed description in D3.9[1]) supports the lifelong learner by monitoring his progress of a selected competence profile, which fits best her goals. The PDP does not only place the lifelong learner in this competence profiles but also assists in acquiring any missing proficiencies for this profile. This is accomplished by letting the lifelong learner select specific learning activities, which help him in acquiring these missing proficiencies.

After having selected the learning goal and a self-assessment, the lifelong learner is provided a tab in which he can plan his learning activities that will help acquiring the required proficiency levels for the relevant competences (see Figure 7). An initial plan is generated by pressing the *generate plan* button, which automatically adds learning activities to the plan. These activities are selected from the competence development plans available for each competence. If desired, the user may modify these learning activities by removing or adding learning activities.

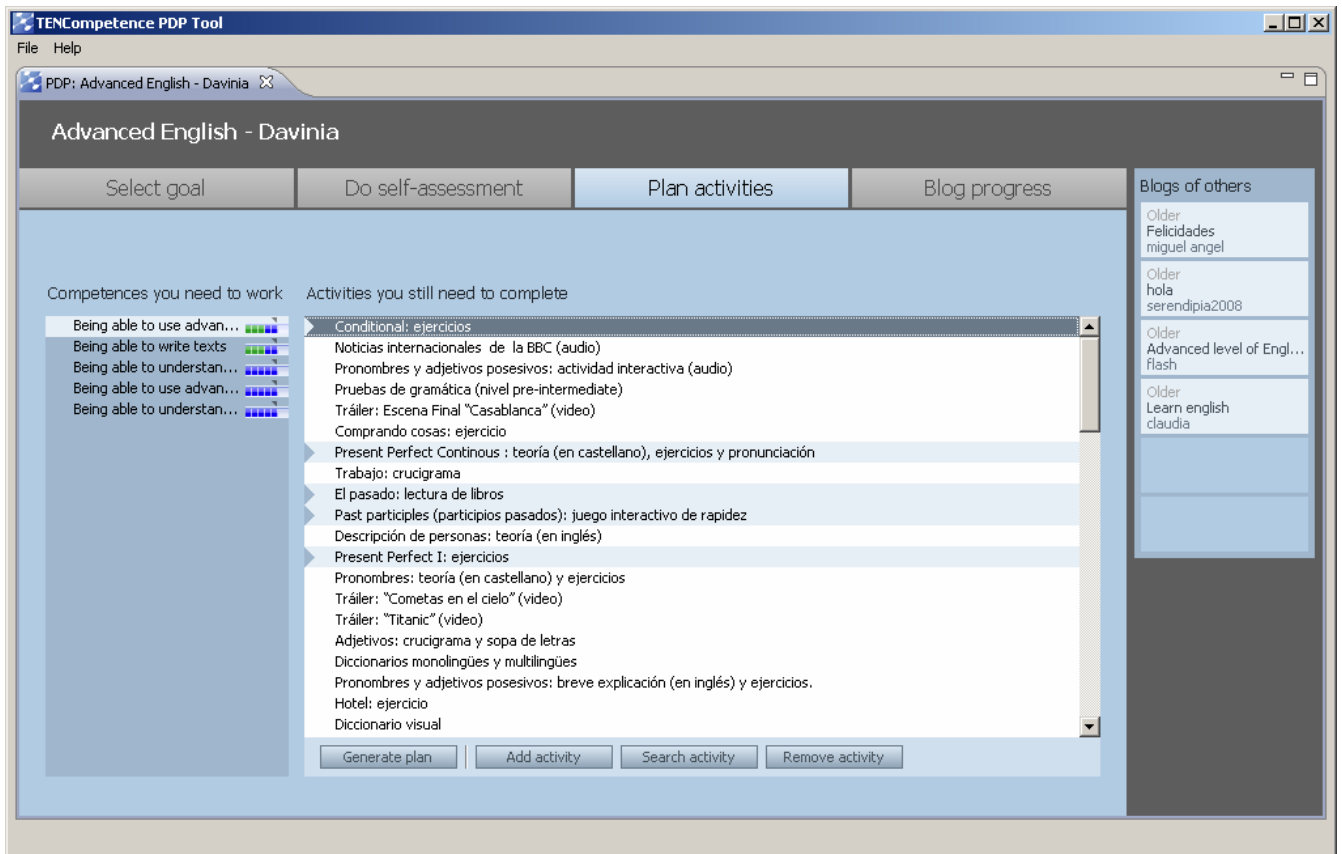[1] http://hdl.handle.net/1820/1725

Figure 7: modifying a personal development plan

The PDP Tool has been extended to incorporate the opportunity to graphically create competence development plans. Now it is possible to call the Graphical Planning Tool from the PDP Tool in Liferay. For this, a button has been added to the PDP Tool that opens the Graphical Planning Tool showing the Learning Activities of concern. The session metadata such as learner status, competences selected, are transmitted in XML to the GPT flash application.

If a learner is overloaded with the opportunities the listed learning activities in the PDP offer him, the GPT provides an overview of the activities in a personalized fashion. This makes it easier for the learner to organize the learning activities since the graphical interface provides a holistic overview and shows better the relations among the items. It further offers drag-and-drop planning functionality and is more intuitive to use. On the other hand, the rather administrative interface of the PDP allows for adding and removing items and is better suitable for inspecting individual activities.

1.3.3 Personalization provided by the Hybrid Personalizer

The presentation of the learning activities in the PDP Tool has to be personalized to the learner. Without the incorporation of the learners status and preferences, the learning activities will not be organized and their relationship will not be easy to grasp. To provide a user-oriented presentation and organization of the learning activities, the Hybrid Personalizer Service is used in the latest version of the PDP Tool.

In D7.2 we presented the Hybrid Personalizer, which provides rates and ranks learning activities, making use of four atomic recommendation services: a *positioning service*, a *navigation service*, algorithmic *curriculum planning* and *preference-based selection*. The Hybrid Personalizer evaluates the learner's metadata and the available learning activities to be presented in the PDP and returns an order that first follows the relationships among the learning activities (which competences are provided by which learning activity that in turn are required by another learning activity) and second

incorporates all other knowledge exposed to the Hybrid Personalizer to adopt the order to the learner's preferences and to the learning network's behaviour. For more detailed descriptions of these services, we refer to D7.2.

Technical Details
The atomic services together with the integrated service on the one side and the graphical user interface of the PDP Planning Tool on the other are separated conceptually. That is, java interfaces as well as Web Service interfaces ease the communication between the components and allow for an ad-hoc adoption to new data or systems (e.g., the forthcoming integration into the PCM). Moreover, a configuration component allows a fine-grained tuning and adoption of how the returned values of the atomic services are used to compute a single personalization value. By this means, the strategy of the hybrid personalization can be modified easily.

This new functionality of the Hybrid Personalizer has been added to the existing Web Service interface available at the Sofia Server (`http://62.44.100.145:8000/HybridPersonalizer?wsdl`).

The interface call has to obey the following signature:

`getOrderOfLearningActivities(ids,metadata,learnermetadata,type)`

`String ids`	a comma-separated list of learning activity ids
`String metadata`	a comma separated list of xml descriptions of the learning activities metadata
`String learnermetadata`	Xml description of the metadata available about the learner
`String type`	the type of recommendation the Hybrid Personalizer should use (e.g., only based on ratings or based on time) – realized as a reference to the Hybrid Personalizer's configuration framework.

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