EHELP - Enhanced E-Learning Repository
The Use of a Dynamic Background Library for a Better Knowledge Transfer Process

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Abstract:

This paper describes an investigation into the ways in which learning and cognition using a web-based e-learning environment can be supported and enhanced by means of a Dynamic Background Library, namely the Enhanced E-Learning Repository Manager (EHELP). The paper focuses on the evaluation of user behaviour based upon such a model, but gives firstly a general overview of the basic idea, design and implementation of EHELP.

1 Introduction

Reflection and introspection of learning activities expose widely the same situation, namely that just studying one particular learning source will not satisfy a deep understanding of new knowledge and not enhance the knowledge acquisition process in terms of overall learning efficiency. Likely anyone will agree that some sort of additional background sources will be needed or at least will be helpful for many learning situations. Moreover, in reference to the well-documented rapid growth of knowledge, the selection of relevant background information will be an increasingly serious challenge. This led us to suggest and implement the dynamic background library (DBL) approach, as first described in [Dietinger et al. 1999].

Our efforts within the field of adaptive content delivery in e-learning environments are supported by many related research works. In the field of static learning assets there exist various initiatives as listed in [NLII 2004], e.g. systems like [Ariadne 2002], and [eLS 2004] manage static learning repositories, and [Edutella 2004] supports the interchange of static learning assets. Moreover, knowledge acquisition and learning processes can be supported by Information Retrieval (IR) activities, as stated in [Baeza and Ribeiro 1999] and [Liaw et al. 2003]. Advances in the field of personalised IR for educational purposes can be found in EU/IST ELENA (see [Dolog and Nejdl 2003]). Finally, some problems related with the 'freedom' and 'chaotic growth' of the WWW, as censorship of information, or reliability, accuracy and topicality of resources can be solved through techniques as "white lists" of servers, as proposed in [Lennon and Maurer 2003], and the Quality Metadata Schema approach discussed in [Guetl 2002]. Thus, it was our intention to implement an overall framework enhancing and solving the just mentioned aspects and problems, respectively.

Our implementation of the DBL is called EHELP (EnHanced E-Learning RePository). Based on a set of self-defined concepts, which describe course and user specific parameters, EHELP generates dynamically context dependent, user relevant and always automatically timely background knowledge that relies outside the static courseware repository by applying an

information retrieval system (IRS). EHELP places this dynamical generated background knowledge at the disposal of learners across distinct viewing modes while navigating through the courseware. Relevance, topicality and access of this background knowledge are maintained using the IRS.
First experiences towards the utilisation of EHELP have shown that learning performance is increased when a Dynamic Background Library is used. Furthermore, the offer of small amounts of additional information seems to arouse further interest in detailed information and related subjects. An extended evaluation towards the use of dynamic background libraries implies at least the following aspects: *(a)* evaluation of the functionality from the authoring and teaching points of view, *(b)* usability of the system from the learners' point of view, *(c)* knowledge acquisition improvement, and *(d)* comprehension improvement by different learner groups. The reminder of this paper gives a brief overview over the functionality of EHELP (section 2), describes the method, results and insights of an evaluation based upon the aspects *(b)* and *(c)* (section 3), and summarises our conclusions and future work (section 4).

2 EHELP

The Enhanced E-Learning Repository Manager (EHELP) is a running prototype developed at the Institute for Information Systems and Computer Media (IICM), Faculty of Computer Science, Graz University of Technology. As already mentioned above, EHELP improves the goal-oriented knowledge transfer process by enabling the development of a dynamically indexed background library of subject-relevant resources residing outside the static repository. The **basic functionality scheme of EHELP**, as shown in Figure 1, depicts the different interaction layers and its dependencies through the knowledge transfer process.

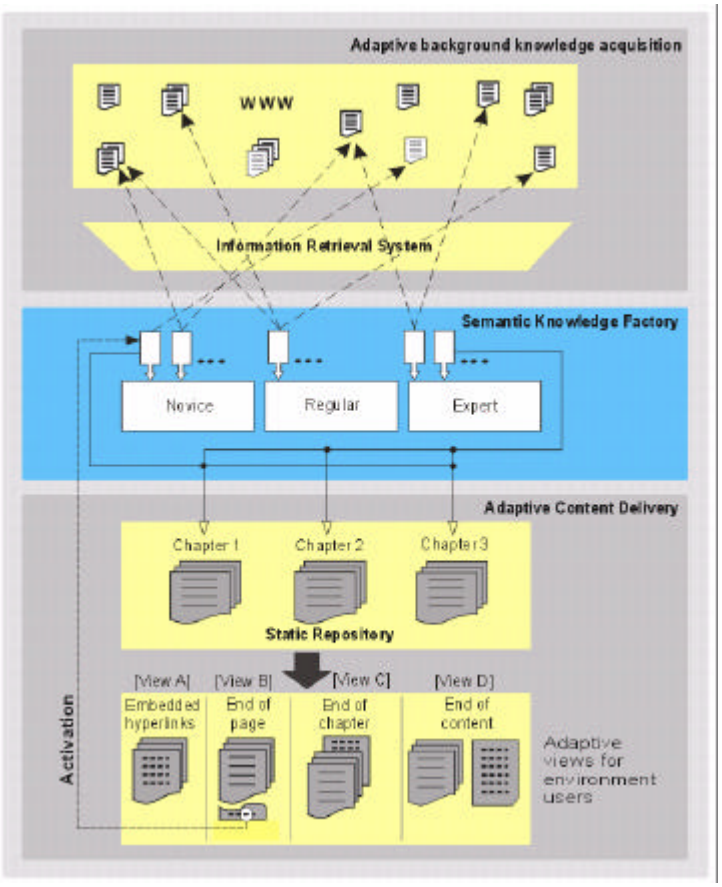

Figure 1: **Basic Functionality Scheme of EHELP**

The background knowledge resources relying on the Internet are dynamically accessed via the IRS, which is implemented by means of a communication layer to the search services xFIND

(see for example [Guetl 2002] and [xFIND 2003]) and Google. This background knowledge is abstracted within EHELP as a set of 'items', which are basically defined within expertise level groups. Furthermore, the items are assigned to one or more course chapters. The set of EHELP items represent the Semantic Knowledge Factory, as illustrated in Figure 1 (middle layer). Depending on the selected viewing mode, the requested page is dynamically generated and contains a list of valid hyperlinked items (see Adaptive Content Delivery in Figure 1). Thus, clicking on a delivered item will lead to a search request to the IRS using the pre-stored and item-specific query term; this process is symbolized in Figure 1 by the arrow 'Activation'. The final result is a set of accurate, relevant and up-to-date documents.

From the **point of view of the learners**, EHELP provides the possibility of choosing their own level of expertise and one of four different viewing modes for displaying the currently valid items while navigating through the course content. Thus, the client side representation of an EHELP item for the learner is given by a specially highlighted hyperlink (e.g. see the item 'intranet' in Figure 2 with its hyperlinked 'book'-icon beside). The four viewing modes are shown in Figure 1 in the layer 'Adaptive Content Delivery' and can be described as follows:

- *Embedded hyperlinks*: The content of the requested page is parsed and modified dynamically depending on the current settings, as depicted in Figure 2 (see also bottom-left side in Figure 1, "[View A]"). Each match is highlighted and hyperlinked to the Information Retrieval System, which hence processes the corresponding search query requests that are passed through the hyperlinked 'book'-icon.
- *End of page*: A list of the matching items is appended 'at the end' of the current page (see bottom part in Figure 1, "[View B]").
- *End of chapter*: Single pages are not modified. At the end of each chapter a dynamically generated HTML page is provided and contains an alphabetical list of the chapter- and level-specific EHELP items, as also illustrated in Figure 1, "[View C]".
- *End of course content*: a dynamically generated HTML page with a list of all level specific items is attached at the end of the course (see Figure 1, "[View D]").

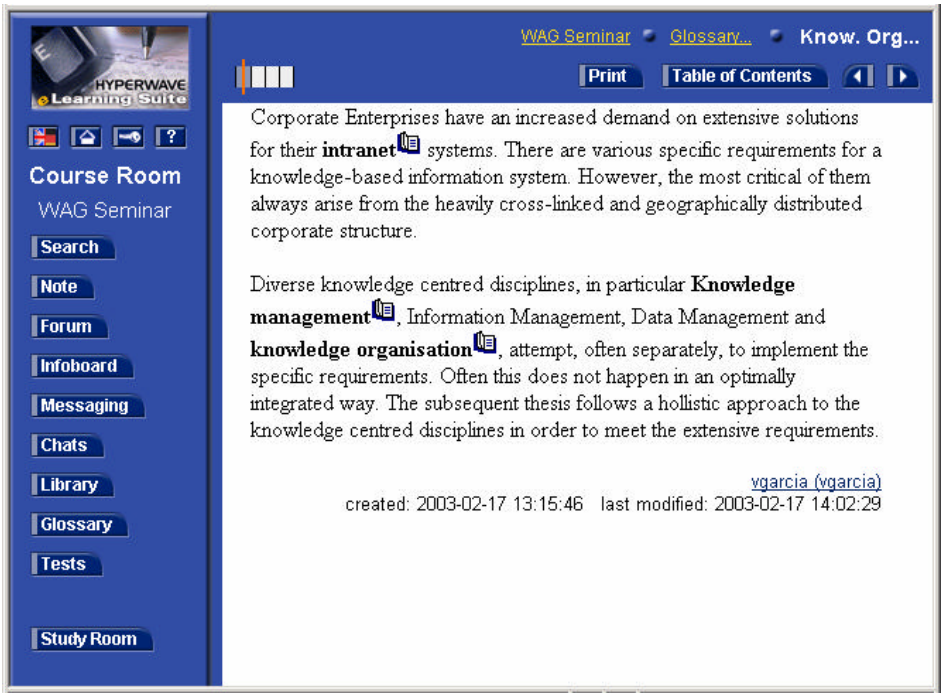

Figure 2: **EHELP viewing mode "Embedded hyperlinks"**

As stated in [García-Barrios et al. 2001], an adaptive tool as EHELP does not only represent an enhanced way of dynamic content reassembly, presentation and navigation. It also eliminates technical inconveniences about data storage and solves the problem of gathering

information that is up to date by interacting with an intelligent search framework. The next section deals with the practical results of an evaluation of EHELP in order to prove its acceptance and practical usefulness.

3 Evaluation

The evaluation of EHELP was conducted as an observed online lesson within the lecture *Information Retrieval* at Graz University of Technology. All students enrolled in this lecture for the summer term 2004 represented the test subject group. The aim of this section is to give a brief overview over the experimental set-up and to depict the main results of the evaluation.

3.1 Evaluation Set-Up

From the technical perspective, the experimental set-up was based on the prototype implementation as described in section 2 (in this case the Google search system was chosen as IRS). Participants of the experiment, in the following for short *subjects*, were requested to consume the online lessons using their own notebooks using a recent version of the MS Internet Explorer browser.

Form the content perspective the knowledge domain *language guessing* was prepared as an online lecture in German language. The content of 18 HTML pages encompassed four chapters. In addition, 28 different search concepts (i.e. EHELP items) were prepared for the dynamic background library. Each chapter was assigned a certain number of these content-dependent search concepts: *Introduction* (14 items), *Introduction in Linguistic* (6 items), *Language Guessing Methods* (11 items), and *Language Guessing Tools* (3 items). The experimental environment as well as the experiment time slot was the same for all subjects. The workflow of the experiment was conducted as follows (the time slice for each process step in minutes is depicted in parenthesis): introduction into the learning platform and EHELP (15), answering pre-questionnaire before online lesson (15), consumption of online lesson (120), answering post-questionnaire after online lesson (15), and short written exam of knowledge acquisition (15).

From the pre-questionnaire some learner attitudes and behavioural characteristics were inferred, like information about computer utilisation, habits regarding general information consumption and preferred media while learning. Relevant information about the learner's behaviour while learning was collected through the EHELP logging features. The post-questionnaire represented a usability test concerning issues about personal background knowledge perception and feedback about the usefulness of EHELP. All aspects depicted so far were combined to gain a deeper evaluative insight into the context of the paper. The next section describes in brief some of the most relevant results and findings concerning the evaluation of EHELP.

3.2 Evaluation Results

The subject group of the experiment consisted of 14 male persons. All of them were either bachelor or graduated students in the subject of software architecture or computer science. 10 subjects (71%) pertained to the age class "15 – 25" and 4 (29%) to "26 – 45". Almost everyone in the subject group indicated to use the computer extensively for work or learning activities and for personal interests as well. 12 subjects (86%) use their computer every day at least one hour, 4 of them even more than six hours for working or learning activities. Again, 13 subjects (93%) use their computer every day at least one hour for private activities, 2 of them even more than six hours.

The usage of specific Internet services is depicted in Figure 3 (see next page). The consumption of the main services *e-mail*, *WWW* and *search* is for nearly 100% 'repeatedly daily'. The usage of *news forums* shows an decreasing tendency. The most noticeable issue in this topic is the fact that a majority (57%) uses *digital libraries* merely "occasionally", while 21% at least "daily". Figure 4 shows an interesting comparison between the consumption of

different media types on paper and on screen. Hence, we may clearly state that more than 90% of the subjects prefer to read *news* from screen, and more than 70% prefer to read encyclopaedias on screen. On the other side, *books*, *newspapers* and *lecture notes* are preferably read on paper. Consequently, we may conclude that subjects like to use the Internet for consultation and in order to acquire recent information. This may one indicator for the need and application of background knowledge.

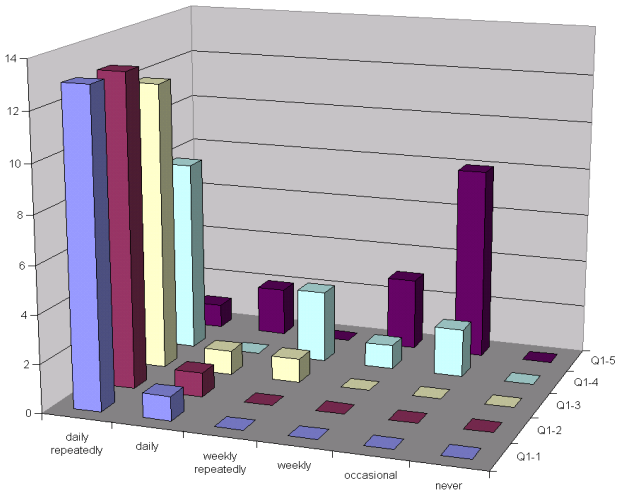

Figure 3: Internet Usage
(Q1-1 E-Mail, Q1-2 WWW, Q1-3 Search Service, Q1-4 News Forums, Q1-5 Digital Libraries)

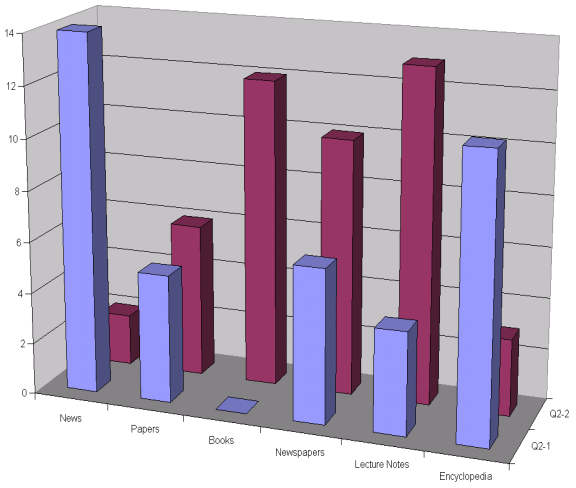

Figure 4: Preferred Media
(Q2-1 Preferred Media on Screen, Q2-2 Preferred Media on Paper)

Figures 5 and 6 depict the learning behaviour of the subjects from the point of view of different sources for knowledge acquisition. The most remarkable issue in this context is the fact that the majority in the subject group use *lecture notes* 'very often' for learning. The subjects do not really consult *journals* for learning, but they tend to consult or include *colleagues and friends* in their learning sessions. The common and regular usage of books has proved itself again. In addition to books and lecture notes for their learning activities, subjects stated the usage of background knowledge of the following resources: timely online information, web sites, Internet recherché, abstracts of lecture notes, test examples, literature references, and lecture notes from other universities.

So far, we can state that our test subjects prefer to learn from lecture notes and books on paper, but are very interested in acquiring additional (relevant and up-to-date) background knowledge and use these additional resources at their learning activities. Considering Figure 3 and 4, it seems obvious exploiting online resources for background knowledge supply.

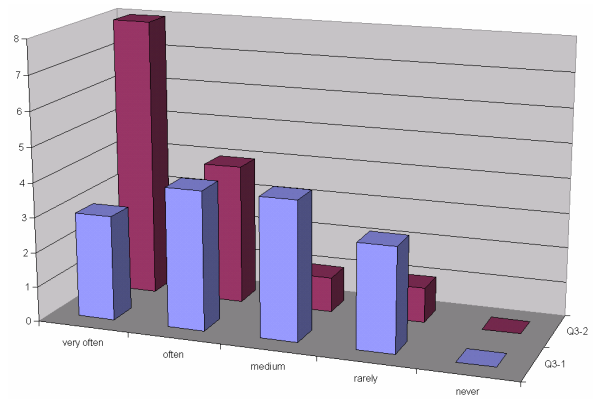

Figure 5: Sources for Knowledge Acquisition - A
(Q3-1 books, Q3-2 lecture notes)

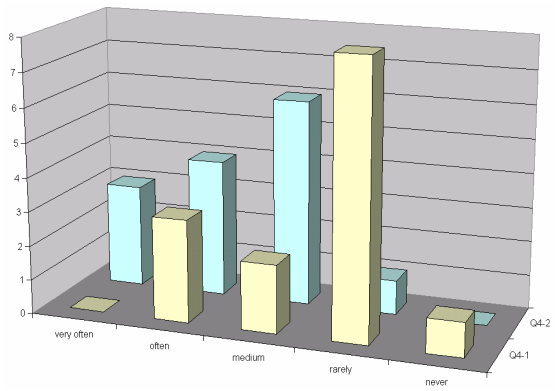

Figure 6: Sources for Knowledge Acquisition - B
(Q4-1 journals, Q4-2 colleagues and friends)

Issues about the usability and efficiency of EHELP could be extracted from the analysis of the post-questionnaire. A graphical representation of issues concerning these topics is given in the Figures 7 and 8. Apart from the fact that the usability of the overall system and the e-learning platform was not rated that well by 2.2 points (1: best … 6: worst), EHELP was rated with an average of 1.9 points, where 43% of the subjects gave EHELP the note "1". Further, a positive feedback could be gained while asking for the efficiency of the information retrieval process through and behind EHELP. Yet, the most important findings were identified through the 'free-text' questionnaire fields in this context. Thus, referring to the subject *usability*, our test persons stated - among others - the following:

- *Particularly I liked…*
  - "Cross references directly embedded in the text"
  - "Idea of graded information behind DBL items according to user's expertise"
  - "Ease of use"
- *I did not like…*
  - "The hyperlinks in the text are too intrusive"
  - "I had to modify queries manually in order to find more useful information"
- *Recommendations for improvement / Helpful suggestions*
  - "Do not mark embedded hyperlinks obtrusively, it is confusing."
  - "Modifications in the *index* of Google may represent a risk, because you may get wrong documents in the future."
  - "Deliver Google results in the user's language"
  - "Build-in a direct linking to cited literature resources (if available)."
  - "Provide direct entries from online-lexica (e.g. Wikipedia or dict.leo.org) and separate them from the search results of Google"

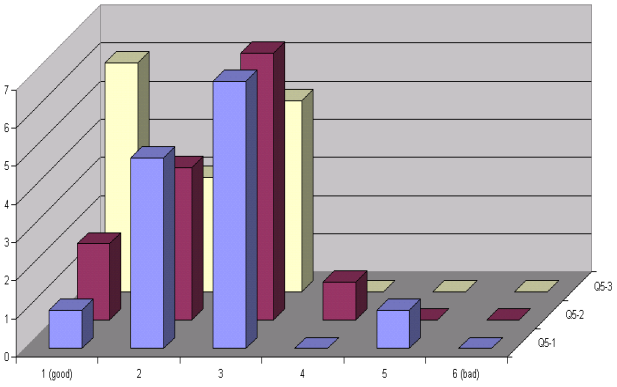

Figure 7: Usability
(Q5-1 overall system, Q5-2 e-learn platform, Q5-3 EHELP)

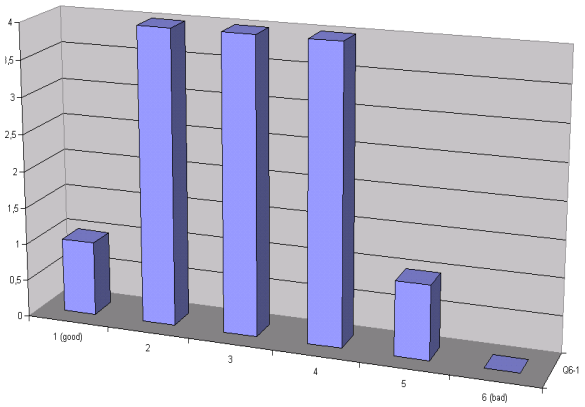

Figure 8: Information Retrieval Efficiency
(Q6-1 finding relevant information behind search concepts)

The last part of the evaluation that we want to describe in this paper concerns the *benefit of the DBL* and the *user interaction preferences*, as illustrated in the Figures 9 and 10 (see next page). A positive tendency may be concluded from the requested personal estimation about the improvement of learning activities through a DBL. The average rate was equal to 2.6 from a 1 to 6 scale (good to bad, respectively; see Figure 9). Figure 10 shows that it is very important for the DBL users to keep control over the personal settings. Users want to select their preferences themselves and modify the settings at their own will and convenience. In the special case of EHELP, users want explicitly to choose and change the settings for their pre-knowledge (e.g. domain expertise) and DBL viewing modes (e.g. presentation modes for DBL items) by themselves.

Furthermore, our test persons stated the following remarks - among others - when requested for the personal benefits of the usage of a DBL:

- "User-tailored and up-to-date tips about relevant and additional literature"
- "Up-to-date information and other perspectives on the subject from different authors"
- "Correction of individual knowledge gaps (e.g. expertise knowledge, foreign words)"
- "Support of autonomous investigation work"
- "Rapid retrieval of specific terminology"
- "User adaptiveness"
- "Refresh the forgotten; consult terms"

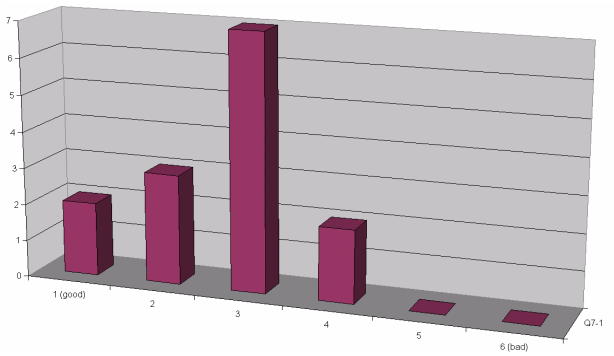

Figure 9: Benefit of DBL
(Q7-1 DBL can improve the learning activities)

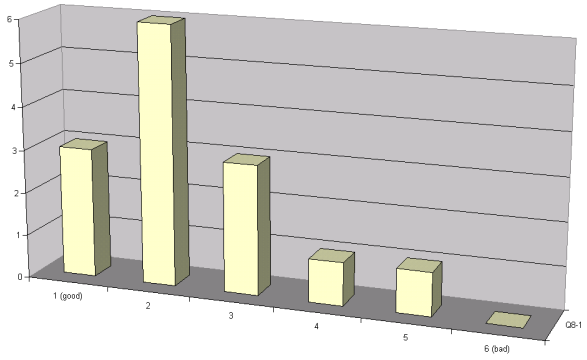

Figure 10: User Interaction Preferences
(Q8-1 importance for the user to select and change setting for pre-knowledge and viewing mode)

Finally, referring to the overall functionality of the EHELP framework, the subject group stated - among others - the following:

- *Particularly I liked…*
  - "Explanations appear on the place, where they are needed"
  - "Providing the possibility to change personal settings"
  - "Well structured and clear"
  - "The DBL works as an activator, deviating from the reading monotony"
- *I did not like…*
  - "Design of DBL links in text"
  - "Not-relevant documents were also found within the Google search results"
  - "Partially, useless results were delivered, or results, which implied a long further search within a web site"
  - "Searching with Google is too global"
  - "Sometimes a manual modification of the search query was needed"
- *Recommendations for improvement / Helpful suggestions*
  - "Enhance design of DBL links in text "
  - "Use tool tips"
  - "Term definitions, which do not have an influence in topicality should be moved to a static glossary"
  - "Provide a built-in library in order to find topic-specific explanations"
  - "Improve the load speed of parsed pages"
  - "If there are too many DBL links defined (e.g. in the *End of Chapter* viewing mode), then structure them better"
  - "Present word explanations in an additional encyclopaedia (e.g. Wikipedia)"

Closing, we want to state that the implementation of a DBL, like EHELP, actually contributes to improve the knowledge transfer process in e-learning environments. Nevertheless, adaptive techniques within the framework yield to complex requirements and functional dependences.

4 Conclusions and Future Work

Like EHELP, adaptive and adaptable tools for e-learning environments represent an enhanced way towards dynamic learning content reassembly, personalised presentation and explorative navigation in e-learning environments. In addition, EHELP eliminates technical inconveniences about data storage and solves the problem of gathering information that is up to date by interacting with a smart search framework, thus, fostering not only reuse and non-redundancy but also topicality of knowledge resources. With respect to the usage of modern dynamic background libraries, like EHELP, at least the following important parameters remain to be evaluated in future work: (1) evaluation of the functionality from the authoring point of view, and (2) detailed knowledge acquisition improvement.

5 Acknowledgements

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