

# Knowledge Maturing in the Semantic MediaWiki: A design study in career guidance

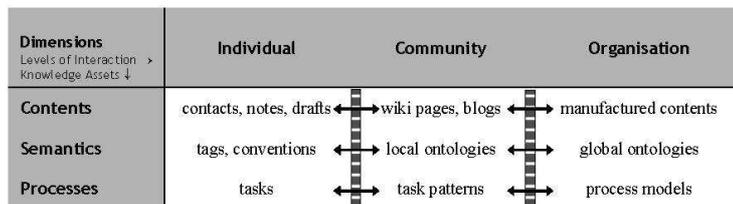
**Abstract.** The evolutionary process in which knowledge objects are transformed from informal and highly contextualized artefacts into explicitly linked and formalized learning objects, together with the corresponding organisational learning processes, have been termed Knowledge Maturing. Whereas wikis and other tools for collaborative building of knowledge have been suggested as useful tools in this context, they lack several features for supporting the knowledge maturing process in organisational settings. To overcome this, we have developed a prototype based on Semantic MediaWiki which enhances the wiki with various maturing functionalities like maturing indicators or mark-up support. We are reporting results of a design study we conducted in the career guidance context to gain insights into the applicability of these features and to derive additional ideas and requirements to effectively support knowledge maturing in an organizational setting.

**Key words:** Knowledge Maturing, Semantic MediaWiki

## 1 Introduction

Resources in an organizational environment change over the time. Since enterprises need to become increasingly agile in order to compete successfully, the adaption of the resource to the users needs and the constantly changing requirements are a crucial factor. Resources like e-mail, web content, documents facilitate the fulfillment of our daily tasks by providing the basis for knowledge intensive work. The improvement and gradual standardization of knowledge artifacts over the time and the accompanying organisational learning processes have been characterized as Knowledge Maturing, see [Schmidt, 2005]. Knowledge Maturing looks at different types of knowledge entities that are important in organizational settings. Besides textual content like documents or e-mail, knowledge maturing is concerned with structures like semantic structures and object hierarchies. Since processes and work flows are permanently adapted and improved in an organizational environment, processes are the third dimension of the knowledge maturing model.

This paper describes a design study conducted in an ongoing EU funded project called MATURE (<http://mature-ip.eu/en/>) where the objective is to understand the maturing process and provide maturing support for knowledge workers in a collaborative environment. The design study as part of the requirements elicitation and analysis aims at identifying requirements for a future



**Fig. 1.** Dimensions of the Knowledge Maturing Model

system supporting the maturing process of knowledge objects. Also, the purpose of the design study is to ground the theoretical ideas of knowledge maturing into organisational practice.

According to the Knowledge Maturing Model introduced in [Maier and Schmidt, 2007], knowledge maturing comprises three dimensions (see figure 1) : content, semantic and processes. Since the system, developed in the design study is based on the (semantic) MediaWiki which deals with articles and meta-data (relations and attributes), the design study covers two of these entities: maturing of content and semantics. In order to provide maturing support for both, we provide indicators that facilitate the assessment of the maturity and tools for improving the content and semantic of knowledge objects. For knowledge maturing support we pursue several approaches – collaboration initiation services for improving documents in a team; semantic search services in order to find useful resources as a basis for writing and editing content; mark-up recommendation for facilitating the creation of meaningful semantic and visualization services to make content and relations visible.

In the section Related Work we give a short overview over related projects on which this work is based and point out some ongoing projects that are related to the same area of research. In chapter 2 we present the maturing support services of the design study in detail and state how these services contribute to the maturing support of knowledge objects. In chapter 3 we present technical aspects of the prototype implementation. Chapter 4 and 5 describe the research methodology, the setting and the results of the design study. Finally, chapter 6 gives a concluding overview and an outlook for future work.

### 1.1 Related Work

There are several approaches analyzing the theory of Knowledge Maturing. [Schmidt et al, 2009] describes conceptual foundations for systems which support knowledge maturing. For that purpose the three dimensions, content, semantics and processes were taken into account. Indicators for content maturing were examined in [Braun and Schmidt, 2007] by analyzing articles within the online encyclopedia Wikipedia. [Braun et al 2008] deals with ontology maturing in folksonomies and [Juffinger et al. 2007] covers ontology evolution in Web2.0 environments. [Ong, Grebner, Riss, 2007] describes the lifecycle of task patterns as part of process management.

[Graham et al., 2008] examined the possibilities of how a personal learning environment could assist the process of knowledge maturing especially focused on the career guidance sector. Additional design studies were conducted in the MATURE project; Closely related to the work of [Graham et al., 2008] is [Ravenscroft et al., 2008] in which a mash up approach to develop services for the Personal Advisors of career guidance organisations and how to support this community of practice within their personal learning and maturing environment is presented. [Nelkner et al., 2008] examined how existing tools can be utilized for knowledge maturing support and present an infrastructure for the integration of the tools in a personal learning and maturing environment.

## 2 Wikis as tools for Knowledge Maturing

Wikis are prime examples of tools that allow for a collective construction of knowledge in a community setting. There are certainly good examples of Wikis being used as tools for creating a collective knowledge repository, for teaching and learning purposes, and for organizational knowledge management, see [Jaksch et al., 2008], [Reinhold, 2006] and [Majchrzak et al., 2006]. In the perspective of a knowledge worker, Wikis might be very well suited for enabling the maturing of artefacts, especially because of the ease of editing the content and the policy that everyone can edit anything. Additionally, they make the collective construction process traceable (utilizing the wiki's history functionality) and allow for discussion processes around artefacts.

Imagine, for example, a career guidance professional who is tasked with consulting a young student in her career choices. It may be the case that the student expresses the wish to become a plumber. Let's assume the career guide is confronted with such a request for the first time, as it is a rather unconventional career choice for the region she has been working in thus far. In the process of guiding the young student, the career guide will be searching external and internal knowledge sources, e.g. of labor market information, will draw on experiences by her colleagues, and slowly construct for herself a way of dealing with this request. At the same time, organisational knowledge is being built up by herself and her colleagues to deal with similar cases more effectively in the future.

Taking this case or similar cases, it becomes apparent that a Wiki – while it may offer a number of relevant features – is by itself not sufficient to support knowledge maturing effectively. This is because knowledge maturing should not be confined to a collaborative editing of artefacts. The following shortcomings can be identified in this respect:

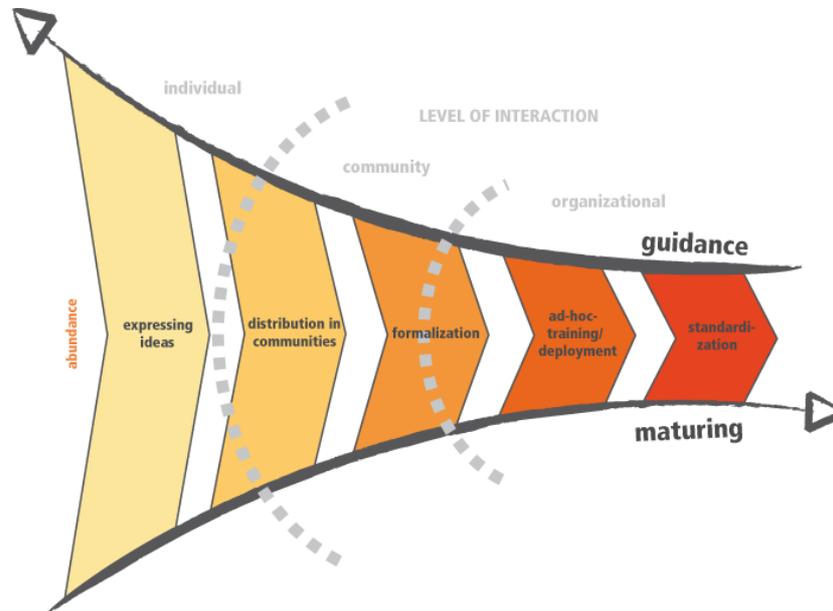
- In constructing organisational knowledge, people usually draw in a number of different sources which vary significantly in the degree of formalization.
- What develops in parallel with documented knowledge is also people's understanding of how artefacts are related and the contexts in which they are useful.

- Negotiation of meaning is a crucial process in organisational knowledge maturing, and this is not effectively supported.
- Degrees of formality and maturity are not captured by existing technologies well enough, and no hints are given in terms of how maturity of artefacts can be improved.
- Reflecting about the knowledge base in its entirety and re-structuring and gardening activities are not well supported in Wikis.

To more effectively support users in the processes mentioned above in a wiki environment, we extended the Semantic Media Wiki ([Krötsch et al, 2007]) with several maturing services. These services seek to bridge existing gaps in the maturing process.

### 3 Maturing Services for the Semantic Media Wiki

User interface functionalities that extend the Semantic Media Wiki in terms of searching, collaborating, adding semantic mark-up and visualisation enhance the knowledge work support for users. An integrated search mechanism enables the user to draw in a large array of different kinds of existing resources from a number of relevant sources (formal reports, statistics, videos etc.) - thus seeding the Wiki with relevant material. The Wiki then renders these existing resources so that discussions and knowledge construction in the Wiki can take place in the context of the formal documents. The rationale for this relates to these informal discussions and knowledge construction drawing together user's knowledge-in-use, which documents experiences from their work. This should enhance the evolutionary growth of the knowledge base. In addition, extensions will be added to the SMW that make use of services from a text mining and information extraction framework in order to provide intelligent services for maturing semantic structures and contents. The Semantic Media Wiki with these additional features should enhance the evolutionary growth of the knowledge base in the context of career guidance. At this stage, we are more interested in exploring the applicability of general principles of knowledge maturing, rather than the applicability of specific technologies. Figure 3 illustrates the phases which are commonly regarded to underly the knowledge maturing process, which are: (I) Expressing ideas (II) Distribution in Communities, (III) Formalization, (IV) Ad-hoc training and finally, (V) Formal training, for details on these phases see [Maier and Schmidt, 2007]). Each of the functionalities supporting knowledge maturing in the Semantic Media Wiki are based on services which can be classified into these phases. The Search Support Service supports developing new ideas concerning a certain topic by enabling the user to browse through various information sources related to his topic of interest like pictures, videos, webpages. The Collaboration Initiation Service helps a user to distribute newly created knowledge artefacts and newly derived ideas in communities. To formalize rather unstructured knowledge, the Mark-up Recommendation Service supports the user by recommending meaningful semantic mark-up and classification of wiki articles. The Maturing Indicator Service together with the Visual



**Fig. 2.** This figure illustrates the Knowledge Maturing phases.

Semantic Browsing Service guides through the overall process, showing the level of maturity of a certain artefact to the user and offering the possibility to get an overview of related articles, authors, semantic relations and browsing through the whole database of the system. Each of these services will be described in detail in the following.

### 3.1 Search Support Service

This service provides a search interface which helps the user to aggregate information related to a certain topic without the need to use multiple search engines. Using different search facilities of various web resources (yahoo search, YouTube, yahoo audio, wiki articles, Xing) and Yahoo Omnifind to enable including local information sources (which are for example only available within an organisation or on one's own computer), the Search Support Service provides a combined interface that is embedded in the edit-mode of a wiki article. By default, the tags suggested by the system on the basis of the existing text in the article, are used as default search keywords, with the user presented the results of this context-specific search. The wide range of information sources, varying between textual content, pictures, persons, ... stimulates the user's inspiration and so provokes the evolutionary growth.

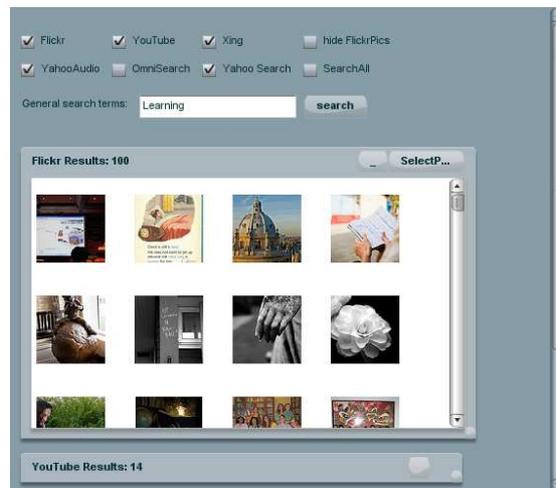


Fig. 3. Search Service - Interface

### 3.2 Collaboration Initiation Service

This service offers the facility to initiate easy collaboration with authors of articles or interested persons via Skype (see fig. 4 (marker 4)) by not having to switch to another tool since it is embedded into the wiki and enables easier use. The user can send messages or web-links to wiki articles in order to support negotiation of and consolidation of artefacts. Additionally, within the visualisation of the wiki network, every author related to an article in the wiki can be contacted by clicking on the author's node.

### 3.3 Maturing Indicator Services

The objective of analyzing content is to facilitate the assessment of the maturity of a document. This maturity level allows to decide whether the maturity of a certain document should be improved by supporting the user in creating or editing a knowledge artefact. The bottleneck in assessing the maturity of text is the selection of qualified attributes reflecting the maturity of the content.

Assuming that the readability and the maturity have a strong correlation, see [Braun and Schmidt, 2007], we tested within the design study two metrics for readability scores where both scores analyse English text samples: In the Flesch Reading Ease test, higher scores indicate material that is easier to read; lower numbers mark passages that are more difficult to read, eg. a score between 90 and 100 indicates that the text is easily understandable by an average 11-year old. The formula for the (FRES) score was developed by [Si and Callan, 2001]. TheGunning fog index is an indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading, see.

The indicator for content maturity is calculated in real time during the editing process of a knowledge artefact. The result of the content maturity analysis can be used to display the current maturity value within the user interface (see fig. 4 (marker 1)) in order to urge the user to improve the text quality. In addition, the maturity level can be the basis for recommendation of documents with a good maturity level. These indicators are based on the content of a wiki article, the semantic indicator provides a quantitative measure for the semantic annotation. Since semantic mark-up is a very important factor for identifying relevant information in the wiki, this indicator should enable the user to assess the amount of semantic mark-up of his/her article and additionally stimulate him/her to add mark-up until the bar switches its color from red to yellow to green. Figure 4 (marker 1) shows a wiki article in the Edit-mode where the user has easy access to those indicators.

**Editing Brighton CI Main Report**

OLME v0.2

categories: report, learn..., evaluate

tags: creative, Brighton, Hove

relations: has author: John, add

Collaboration: Search ..., Update

readability: 11.7, 28.6

semantic: [red bar]

1

2

3

4

Skype Interface

name	status
nicolas.weber	ONLINE
kasimiro.austri...	N/A
testuser	

Send a message to user  
Send this wiki page to user  
Bildaktualisierungsbereiche anzeigen  
Debugger  
Einstellungen...  
Über Adobe Flash Player 9...

cancel

Executive Summary: the creative industries in Brighton and Hove  
Hove  
The creative industries play a central role in the reputation, profile and economic strength of cities. They are one of the fastest growing sectors of the economy, at \$4 per annum, twice the overall UK growth rate. A lot of this is private sector enterprise - from micro businesses to multinationals. The creative industries add value to the life of the city by contributing to social, economic and environmental regeneration - inward investment, helping to retain creative and skilled workers within a city and attracting visitors from the UK and beyond.  
In Brighton and Hove, there are many opportunities to establish the city's reputation for creativity in the first part of the new century. This needs to be strongly grounded on getting a number of basic requirements right in the public and business domain. These include an uncompromising search for quality and success, the right kinds of encouragement for people and companies, and good connections allowing creative businesses to help make the city a more prosperous and better place to live. All of this should aim to make a measurable difference to the city and the quality of life of

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Summary:

This is a minor edit  Watch this page

Save page Show preview Show changes

**Fig. 4.** A Semantic Media Wiki Edit-Page with additional feature bar

### 3.4 Mark-up Recommendation Service

Creating semantic mark-up conveys to the enrichment of wiki content. The Semantic MediaWiki extension introduces named relations and attributes for articles and so it broadens the expressiveness of the usual wiki mark-up. This additional annotation of articles enables the user to browse through the wiki and facilitates the retrieval of knowledge based on semantic mark-up. In addition, mark-up is used as a basis for recommendation of useful resources and visualisation of emergent content structures. The markup recommendation services strive for two goals. First, lowering the barrier for creating mark-up which replaces the complex Semantic MediaWiki syntax and second, improving the quality of structure by recommendation of meaningful, pre-consolidated mark-up. Since the user contributes to the organisational knowledge and benefits only indirectly, creation of mark-up has to be easy and fast. Markup Recommendation Services are connected to both, the content on which the mark-up is based and the semantic structure which describes the content. Thus, the Recommendation Service is able to compute the relations and attributes based on the content and it eases the creation of mark-up by accessing the semantic model directly. A bottleneck in the creation of semantic annotations such as relations, attributes, tags is the inconsistent vocabulary. Ambiguity, misspelling, similarity of term semantic hamper the creation of meaningful annotation necessitate the correction and consolidation of the semantic structure. Thus, the Recommendation Services use NLP techniques for the discovery of semantic relations and attributes. By mapping the identified mark-up to a common vocabulary, the service avoids inconsistencies within the semantic model. A design principle in developing recommendation services was to make sure that the user keeps the control. The objective of the services is not to create mark-up automatically, they should rather provide support by recommending annotations. Depending on the content of an article, the system analyses used words and their frequencies to recommend the most used keywords as tags for the article, see fig. 4 (marker 3). In order to categorize articles, the system suggests already existing categories which corresponds best to the newly created content, see fig. 4 (marker 2). Additionally, the user can add a certain category which seems to be appropriate and can train the service with this category such that the system can suggest this category in future for appropriate and related articles.

The recommended category can be added to the article by clicking the add button. The user is enabled to improve the precision of the classifier by training the classifier using the learn function. The Semantic MediaWiki is enhanced with support for easy-use of SMW mark-up so that no user has to be familiar with the markup to write quality improved articles. Semantic mark-up supports the author and - most important - other users, to refine articles concerning a certain topic of interest. The mark-up recommendation bar is divided into two areas: tag recommendation and relation selector. This wiki extension aims at making tagging of resources as easy as possible. The system recommends a pre-consolidated set of tags, based on the result of content analysis. Adding a tag to the article needs just one click on the recommended tag.

### 3.5 Visual Semantic Browsing Service

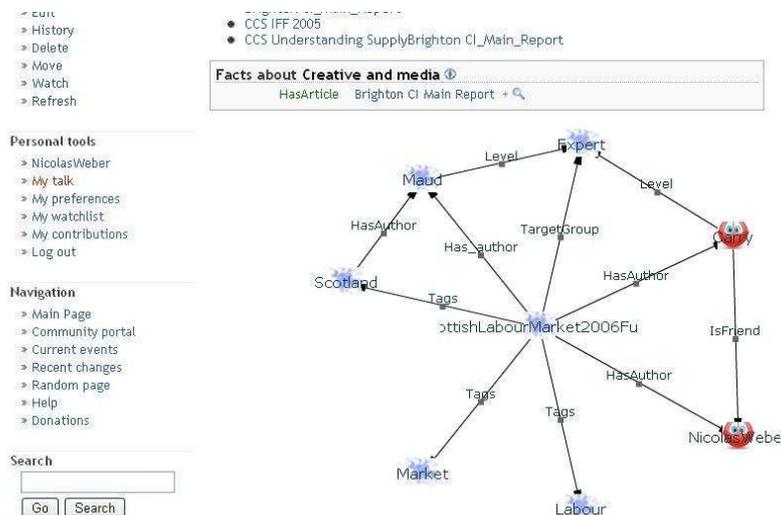


Fig. 5. Visualisation Service

This service provides a visualization for the content of the Semantic Media Wiki. Each node in the graph represents either an article in the Wiki or a registered user. Directed edges represent the relations, for instance an article might have an assigned category, author, tag or linked article. A user might have written one or more articles, or a category might contain one or more sections, articles, tags, etc. Depending on the choice of the maximum shown path-length, the user can define how many levels (and nodes) of the network are shown in the visualisation, as well as the type of the representing graph (e.g. hierarchically, cyclic). By clicking on a node in the graph, the visualization is updated and its connected nodes are shown, which enables the user to browse easily through the content of the wiki within the graph. Additionally, new nodes (users or articles) can be created; articles corresponding to a certain node in the graph can be opened and edited in a new browser window; and users corresponding to nodes can be contacted by using the Collaboration Initiation Service. This service supports the daily work of users by enabling visual browsing through wiki content from article to related articles or users. Thus, it assists by providing an overview of related topics and experts and offers easy negotiation by embedding a collaboration service.

## 4 Implementation

The basis of the developed prototype is built up by the Semantic Media Wiki, whose basic source code and skin is adapted to include the Search Support Ser-

vice, Mark-up Recommendation Service, Maturing Indicator Services and Collaboration Initiation Service. A MediaWiki extension was developed to include the Visual Semantic Browsing Service. Fig. 6 shows a schematic illustration of the software architecture and in the following, the offered services and their implementation are described in more detail.

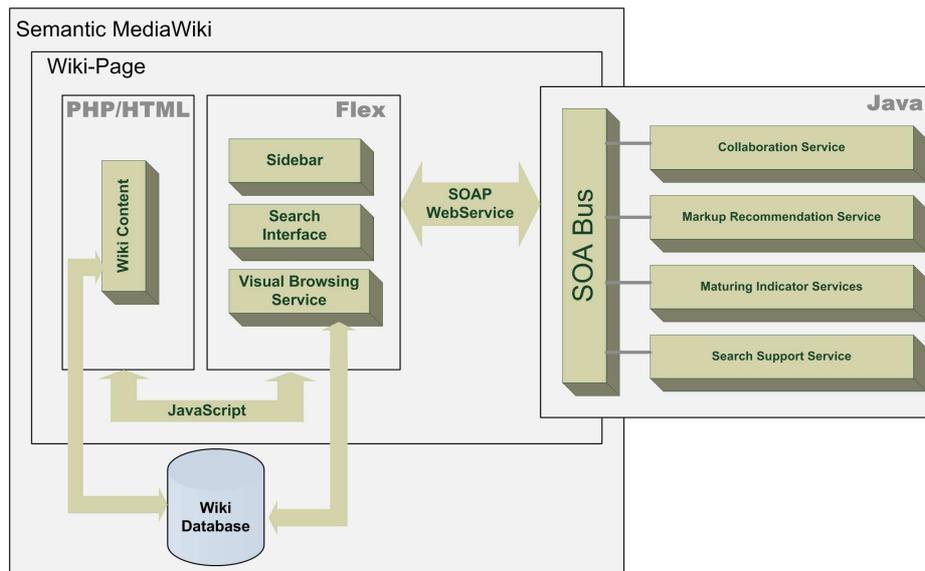


Fig. 6. Illustration of the system architecture

In the back-end of the Search Support Service various API's are accessed to extend the knowledge database of the Semantic MediaWiki with existing information sources available in the web and locally. These include the yahoo search engine (standard search, search for audio files and restricted search in the www.xing.com domain for searching experts on a certain topic), Flickr photo service and the YouTube video service. The Collaboration Initiation service is based on Skype for connecting a registered MediaWiki Skype user and other Skype users. Therefore a python wrapper for the Skype API is used to enable messaging between Skype and python scripts, which in turn are accessed as Remote Objects by Flex using the AMF protocol.

## 5 Evaluation in a real world context

In order to gain insight into and to obtain new ideas about how a system could support the knowledge maturing process, a prototype was developed and evaluated in a real world context of career guidance organizations, whose service is delivered by specially trained Personal Advisers (P.A.s). They are based in

schools, colleges, at special Access Points, and in a range of community settings and P.A.'s can help (young) people with all sorts of personal issues, including employment and training. They are required to consult with individuals on their job prospects and advise them on potential careers in the context of the regional labour market situation. The typical every-day work of a personal adviser can be separated into the following maturing stages: (1) Aggregating and Scaffolding; (2) Manipulating; (3) Analysing; (4) Storing; (5) Reflecting; (6) Presenting; (7) Representing; (8) Sharing; and (9) Networking with other people. See [Graham et al., 2008] for a detailed description of this steps in the context of career guidance and its importance on the knowledge maturing processes in a personal learning and maturing environment.

Labour market information is heavily context dependent, dynamic and is currently stored in a number of different information sources including various local databases and people's memory. Practitioners gather a considerable amount of experience during various consultations, nevertheless their gained informal knowledge is only more or less systematically shared between colleagues. Due to the fact that the MediaWiki technology offers dynamic and collaborative updating of content in an intuitive and simple manner and the Semantic Media Wiki offers the possibility of enriching this formal knowledge with semantic technology, the SMW would support the every day work of a practitioner reasonably: It easily enables users to create, disseminate, share and collaboratively improve local labour market information. Semantic and readability indicators for the quality of a written wiki article supports the author to improve the content for increasing the probability of being read and refound. Additionally, the user benefits from the easy addition of Semantic Media Wiki mark-up, such that he/she does not need to know the wiki-syntax and so is therefore more likely to be motivated to start using the system. The Semantic Media Wiki is enhanced with Web2.0 technology, to source content from other places like YouTube, Yahoo, Flickr etc to support the aggregation and scaffolding process. Furthermore, the prototype has integrated useful collaboration tools such as Skype supporting a practitioner in networking with others. To support the aggregation and reflection phases of a practitioner, a visualisation of the whole wiki knowledge base including links between articles, semantic annotations, categories and authors gives a complete overview. This enables the user to browse through the whole available content, find related articles and detect similarities for some gardening or reseeded activities, taking care that the content within the system is accurate.

## 5.1 Results

In a workshop together with people from career guidance organisations, who are potential users of the system, the prototype was presented to get feedback on whether it provides promising support in the maturing process and for the every-day work of a personal advisor. The participants noted the interesting potential of the system to assist this process though some problems have to be solved. The system provides an easy-to-use way to share local labour market information. If developed further, a 'One Stop Shop' approach offers great potential to bring

together vacancy information, easy access to collaboration tools for connecting with other people in and outside the organisations and interoperability with other systems. The wiki holds great potential to support knowledge flow and storage and hence supports knowledge maturing. Though, motivation for highly pressurised employees to use this systems was mentioned - it is crucial that the benefits to individual employees are greater than the effort required to engage with the system - and the developed tool seemed to provide the potential to save valuable time in challenging work scenarios. Nevertheless, it was acknowledged that widespread implementation of this type of system would need a cultural change within organizations, led by senior management. Although the feedback on the system was extensive, some usability issues and possible improvements were identified, which will be discussed in the next sections.

## 5.2 Application Requirements for a system to support knowledge maturing in a career guidance context

Several usability issues were identified. The most important relates to the environment and representation of the system crucially depending on the position of a user within a company as individuals occupying different positions will have different requirements from the system. Secondly, the representation of the system should offer the user the option of adapting it, according to their personal learning style. Additionally, the representation of a knowledge artefact or author should depend on its level of maturity (e.g. depending on the content, semantic, user statistics and/or rating) such that the user can decide at a glance on the importance on a document, article etc while browsing the content. Another important issue came up concerning accuracy control, safety and data protection of the system. Most of the participants assumed that a moderator would be needed to keep the system up to date and prevent people from skewing the content. In the context of knowledge maturing, such a role would enforce the organizational perspective and provide guidance. Furthermore, where personal advisors were placing all their explicit knowledge about a certain topic into the wiki knowledge base, then selections of relevant information for presentation to different groups of clients would be required (e.g. young people of different ages and abilities, situated in various schools)

*Visual Appearance* Visual adaptation of the system would be necessary depending on individual preferences and learning styles. The easier a user can adapt the system to his/her needs, the more likely is it that the motivation of using a system for every day work grows.

*Easy access to relevant information* Users might lack time to research information and therefore would need easy access to which articles are relevant for them. To support this, each article could have a summary which is shown when articles are listed as a search result or on the top of a page. Additionally, this summary could be shown within the visualisation of the wiki content when an employer moves the mouse over a node representing this article. Automated and Manual

Article Rating could improve and support search facilities. The system should be able to recognise articles which are consulted more often and present these first. This could be supported by using a rating system including automated and people rating processes.

*Third-Party Access* The ability of clients or trainers from other organisations to be given direct access to the system allows them to 'self-manage' the system by navigating their way to specific topic they are interested in, etc. job vacancies.

*Accuracy control concerning time and content* is necessary to make sure the data is accurate, up-to-date and relevant. Long articles are unlikely to be read and it will be too time consuming to search through for the information a user is looking for. Instead of a moderator, the idea of automatic date flags could be used to remind authors and editors to update a certain knowledge artifact. Though, depending on the live time of an article, one has to take into account that some articles are more general than others and could therefore have a longer shelf-life. Furthermore, a method of controlling the amount of data added should be available to make sure information is concise, authors should be made aware of relatively similar articles and of the amount of content in their articles.

*Awareness for collaboration* Collaboration in organisations support employers to discuss new ideas and to provide help when questions arise or problems are encountered. The user should be able to see immediately who is online and who is not to be aware of whom to ask for help or discussion. Furthermore, various collaborations tools (Skype, ICQ, ...) could be combined..

*Integration of other systems* Employers starting to work with a new system, eg. the Semantic Media Wiki, easy support has to be provided to integrate other sources of information, such that there is an immediate benefit by using the system. Having a 'one stop shop' that gets all requirements collected in one database would save busy users from searching through different information bases as users have a need to find relevant information rather than creating a completely new knowledge base.

## 6 Conclusion

The main purpose of this work was to gain insight into the knowledge maturing process in the real world context of career guidance organizations by developing a tool that supports this process. The potential of the system in this context was to be explored and it was to be researched how the utility of this system could be further enhanced. To support newly appointed personal advisors of career guidance organisations in a typical working process and the corresponding stages of knowledge maturation, a Semantic Media Wiki was employed which was enriched by several user interfaces that extend the usability of the Wiki in terms of collaboration, content visualisation and easy use of the system. Several

maturing indicators and services have been designed that try to bridge the gaps in the maturing process. Furthermore, an evaluation of the prototype in a real-world-context helped to gain a deeper insight on features that are relevant for supporting knowledge maturing in career guidance organisations and the main aspects of their requirements can be easily adopted for a system supporting knowledge maturing of a knowledge worker in other contexts.

[Graham et al., 2008] provided an approach of how a personal learning and maturing environment could be realised by a Mash-Up PLME which is generally seen as a collection of loosely coupled tools, including Web 2.0 technologies, used for working, learning, reflection and collaboration with others. Nevertheless, they were still unclear how the individual and organisational context within a learning and maturing environment can be merged. This work tried to show a possible realization for a seamless integration and provided further ideas to enhance and develop functionalities for both perspectives.

## 7 Outlook

The project, within this design study was carried out, has a number of application partners for piloting the tools and processes being developed. Thus, the next steps in our work will be to continue this design study and accomplish the derived design ideas how to support knowledge workers in the phases within this context and repeat the feedback process. We will identify additional indicators and metrics and test their significance in terms of maturity in order to analyze and support the content maturing process better.

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## References

- [Braun and Schmidt, 2008] Braun, S. & Schmidt, A. (2008), *People Tagging & Ontology Maturing: Towards Collaborative Competence Management*, in '8th International Conference on the Design of Cooperative Systems (COOP '08), Carry-le-Rouet, France, May 20-23, 2008' .
- [Braun and Schmidt, 2007] Simone Braun, Andreas Schmidt, *Wikis as a Technology Fostering Knowledge Maturing: What we can learn from Wikipedia*, In: 7th International Conference on Knowledge Management (IKNOW '07), Special Track on Integrating Working and Learning in Business (IWL), 2007
- [Graham et al., 2008] Graham Attwell, Jenny Bimrose, Alan Brown, Sally-Anne Barnes, *Maturing learning: Mash up Personal Learning Environments*, In: Fridolin

- Wild and Marco Kalz and Matthias Palmr (eds.): Proceedings of the First International Workshop on Mashup Personal Learning Environments (MUPPLE08) Maastricht, The Netherlands, September 17, 2008. In conjunction with the 3rd European Conference on Technology Enhanced Learning (EC-TEL'08), Maastricht School of Management, Maastricht, The Netherlands, September 18-19, 2008, CEUR Workshop Proceedings vol. 388, 2008
- [Granitzer, 2006] M. (2006). Granitzer, *Konzeption und Entwicklung eines generischen Wissenserschliessungsframeworks*, PhD thesis, Know-Center, Austria.
- [Jaksch et al., 2008] Jaksch, B., Kepp, S.J., Womser-Hacker, C.: *Integration of a wiki for collaborative knowledge development in an e-learning context for university teaching*. In: A. Holzinger (ed.) HCI and Usability for Education and Work, Lecture Notes in Computer Science, pp. 7796. Springer, Heidelberg (2008)
- [Juffinger et al. 2007] Juffinger A., Neidhart T, Granitzer M., Kern R., Scharl A. *Distributed Web2.0 Crawling for Ontology Evolution* International Journal of Internet Technology and Secure Transactions
- [Kröttsch et al, 2007] Markus Kröttsch, Denny Vrandečić, Max Vlkol, Heiko Haller, Rudi Studer. *Semantic Wikipedia*. In Journal of Web Semantics 5/2007, pp. 251261. Elsevier 2007.
- [Maier and Schmidt, 2007] Ronald Maier and Andreas Schmidt, *Characterizing Knowledge Maturing: A Conceptual Process Model for Integrating E-Learning and Knowledge Management*, In: Norbert Gronau (eds.): 4th Conference Professional Knowledge Management - Experiences and Visions (WM '07), Potsdam, GITO, 2007, pp. 325-334.
- [Majchrzak et al., 2006] Majchrzak, A., Wagner, C., Yates, D.: *Corporate wiki users: results of a survey*. In: D. Riehle, J. Noble (eds.) WikiSym 06: Proceedings of the 2006 international symposium on Wikis, pp.99104. ACM, New York, NY, USA (2006)
- [Nelkner et al., 2008] Tobias Nelkner, Wolfgang Reinhardt, Graham Attwell, *Concept of a Tool Wrapper Infrastructure for Supporting Services in a PLE*, In: Andreas Schmidt and Graham Attwell and Simone Braun and Stefanie Lindstaedt and Ronald Maier and Eric Ras (eds.): 1st International Workshop on Learning in Enterprise 2.0 and Beyond, CEUR Workshop Proceedings vol. 383, 2008
- [Ong, Grebner, Riss, 2007] Ernie Ong, Olaf Grebner, Uwe Riss: *Pattern-Based Task Management: Pattern Lifecycle and Knowledge Management*. In: WM 2007 Proceedings of the 4rd Conference Professional Knowledge Management. IKMS 2007 Workshop Potsdam, Germany, 2007, pp. 357-364.
- [Ravenscroft et al., 2008] Ravenscroft, A., Braun, S., Cook, J., Schmidt, A., Bimrose, J., Brown, A. and Bradley, C. (2008) *Ontologies, Dialogue and Knowledge Maturing: Towards a Mashup and Design Study*. CEUR Workshop Proceedings, Vol. 383.
- [Reinhold, 2006] Reinhold, S.: *Wikitrails: augmenting wiki structure for collaborative, interdisciplinary learning*. In: D. Riehle, J. Noble (eds.) Proceedings of the 2006 international symposium on Wikis, pp. 4758. ACM Press, Odense, Denmark (2006)
- [Schmidt et al, 2009] Schmidt, Andreas; Hinkelmann, Knut; Ley, Tobias; Lindstaedt, Stefanie; Maier, Ronald & Riss, Uwe: *Conceptual Foundations for a Service-oriented Knowledge and Learning Architecture: Supporting Content, Process and Ontology Maturing* Springer (2009)
- [Schmidt, 2005] Andreas Schmidt, *Knowledge Maturing and the Continuity of Context as a Unifying Concept for Knowledge Management and E-Learning*, In: Proceedings of I-KNOW 05, Graz, Austria, 2005
- [Si and Callan, 2001] Si, L., Callan, A. J. (2001). *Statistical model for scientific readability*, In Proc. of CIKM, pp. 574-576.