Positioning and Navigation: Services for open educational practices

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Abstract:

To choose suitable resources for personal competence development in the vast amount of open educational resources is a challenging task for a learner. Starting with a needs analysis of lifelong learners and learning designers we introduce two wayfinding services that are currently researched and developed in the framework of the Integrated Project TENCompetence. Then we discuss the role of these services to support learners in finding and selecting open educational resources and finally we give an outlook on future research.

1 Introduction

The role of content for technology-enhanced learning has been attributed a lower priority from several recently stressed theories and models of learning like socio-constructivist theories [1], situated cognition [2] or constructionism [3]. In addition the role of user-generated content is currently intensively discussed with its impact and importance on learning and competence development [4]. Nonetheless, learning content is still an important factor for technology-advanced learning and a huge amount of learning content is critical to allow a wide-scale diffusion of self-directed lifelong-learning for the individual. In the past several initiatives have been started to offer learning resources on a wide-scale on the internet for free. One of the first and most successful initiatives was the Opencourseware project from the Massachusetts Institute of Technology in which the content from 1550 courses has been made publicly available. Several initiatives followed and initiated a new discussion about openness and access to learning resources in education. The UNESCO summarizes these new development 2002 in their Forum on the Impact of Open Courseware for Higher Education in Developing Countries as "the open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes" [5].

Although the availability of open educational resources is currently increasing there is a lack between the mere availability of these resources and the educational use of the available material. To fill this gap it is important "how educational repositories of Open Educational Resources, which often want to grow based on user contributions and sharing among users, will manage to become more useful for communities of practice" [6]. The increase of open access and the publication of open educational resources do not imply the creative use of these resources for learning. This paper presents two services that are currently developed in the framework of the European Integrated project TENCompetence. These services deal with a similar problem that user of open educational resources are faced with. The next part of the paper deals with user requirements and existing technological solutions to improve the competence and learning related search and use of open educational resources. Then we present positioning and navigation as two independent but connected services that can help learners to decide about which learning activity or resource to choose as next step in their personal competence development. Finally, we discuss the (dis)advantages and give an outlook about future research.

2 Supporting learners and learning designers to find suitable OER

The main users for open educational resources are self-directed learners on the one hand and learning designers on the other hand. Both groups have specific requirements for using open educational resources for learning or designing learning opportunities. First of all, learners need to have orientation to choose the best suited learning activities from the vast amount of available resources. The label "best-suited" implies several options regarding the choice of material. In general the best suited resources for learners are the ones that help them to reach the "zone of proximal development" [7] regarding their competence development goals. This zone can be identified through an analysis of the learners' prior knowledge, his topical interest and/or a comparison to the next steps similar learners have taken.
For learning designers it is important to know which resources can be combined to produce a sound competence development program for learners. Again, there are several aspects for learning designers to decide about the appropriateness of open educational resources for constructing learning activities and courses. They have to address their target group based on specific characteristics like 1. prior knowledge, 2. learning goal, 3. study time, 4. preferred study style 5. demographic information like age and sex.
Therefore, the most important problem for both user groups is an individualized search facility tailored to their needs and competence development targets. This search-and-find problem can be addressed on several levels: On the level of the learning objects, on the level of the technology for storing the objects (the repository level) and on the user level:

- **Learning Objects Level**: To unify the description of learning resources the IEEE LOM standard has been used in many repositories to describe the contained resources [8]. But the IEEE LOM standard has been criticized because of its limited possibilities to enrich learning objects with educational meaningful information [9]. In addition, research has shown that it is not recommendable to let authors enrich learning objects with metadata because this does not lead to sufficient quality of the metadata [10]. To ensure high qualitative metadata domain experts are needed who tag the resources with an agreed upon taxonomy of keywords. As an alternative to IEEE LOM several repositories use an extended set of the Dublin Core Standard [11]. This extended set offers more flexibility to enrich learning resources with educational and competence development related information but in essence the expert problem remains.

- **Repository Level**: On the level of the learning object repositories the Open Archive Initiative Protocol for Metadata Harvesting (OAI PMH) was a first step towards pooling of resources from different origins [12]. Currently, the work on the Simple Query Interface (SQI) has enabled interoperability for search between repositories [13]. This intra-repository specification allows users to find learning objects in several distributed repositories.

But solutions on the level of the object and the repository do not address the problem that the success of the search is still dependent to a large extent on the quality of the metadata attached to the learning objects. Additional approaches on the user layer are needed to address the above described problem description for users of open educational resources. Especially when the search functions should address and support competence development user contribution is needed to add this information to the learning resources in open content repositories. These distributed resources are not only used in "formal learning environments" but also used by distributed self-directed learners who use them in a more informal way.
In the European Integrated Project TENCompetence we are currently researching ways to personalize distributed learning resources, units of learning and competence development programs in learning networks [14]. Two wayfinding services on the user level are responsible to offer individualized competence development programs in learning networks. The positioning service analyzes the prior learning of learners through a content analysis method while the navigation service recommends the next best learning activity for a student. In this contribution we introduce these services and discuss their potential as a bridge from distributed open educational resources to open educational practices.

3 TENCompetence wayfinding approach

To provide learners with orientation for their competence development our research focus is to answer the following questions: Where do I stand in the "curriculum" and which step should be next? To answer this question we have conducted research how to support this orientation process with technology. Two services haven been recently implemented and tested in the framework of the TENCompetence project: A positioning service uses language technology for prior learning assessment while a navigation service applies research from recommender systems to help learners to find orientation.

3.1 Positioning

Especially from the perspective on lifelong learning it is an important question for learners where they should start their competence development on the basis of what they already know and what they want to achieve as competence development goal. In traditional educational settings this problem is addressed through the Accreditation of prior learning (APL) [15]. This process – which is most of the times carried out the submission phase of study programs in Higher Education – relies on domain experts who study the portfolios of learners and decide about exemptions for them. Due to the fact that this is impossible to follow this approach when people change their domains and institutions quite often during their life, we use language technology to support this process.
Our current project uses Latent Semantic Analysis (LSA) to support the APL process for technology enhanced learning. Latent Semantic Analysis (LSA), in the past sometimes referred to as Latent Semantic Indexing (LSI), is used to calculate a similarity between the learner documents and the learning resources. LSA is a theory and method for extracting and representing the contextual-usage meaning of words by statistical computations (16). The whole process of this analysis consists of several steps like the pre-processing of the text, some weighting and normalizing mechanisms, the construction of a term-document matrix and a mathematical function called singular-value decomposition (SVD), which is similar to factor-analysis. The end result of this process is a latent semantic space, in which the main concepts (or types) of the input are represented as vectors. Concepts in this space are similar if they appeared in the same context and so their vectors are close together in the space providing a measurement for the similarity of text. LSA is applied in several research fields like informatics, psychology or medicine.

The most prominent example for the use of LSA in an educational environment is the assessment and feedback of free text in intelligent tutoring systems. Some examples of these applications are the Intelligent Essay Assessor (17), Summary Street (18) and Select-a-Kibitzer (19) to mention only a few. Some researchers have used LSA to provide students with appropriate texts that fit to their current knowledge [20,21].
Our application of LSA is similar but has a different motivation and context. We are using LSA to assess prior knowledge of learners for placement or positioning decisions and finally the construction of personalized learning paths through a learning network. A high correlation between documents in the portfolio and learning resources leads to an exemption of this specific learning activity. The result of these analyses should be taken into account for the creation of a personalized learning path. Some learning activities on the way to the target competencies a learner wants to achieve may be exempted because of the results of this prior learning analysis. We conducted an expert validation of the positioning service and compared the results of LSA to results that experts have given. The first results of the service look promising.

3.2 Navigation

Navigational support is necessary for providing learners with appropriate learning resources when there is not a clear curriculum. We have recently designed a navigation service as a personal recommender system (PRS) for learning resources. The general concept of the PRS is in line with hybrid recommender systems in other domains. Hybrid recommender systems combine different kind of recommendation techniques to achieve a higher accuracy in their recommendation [22, 23, 24]. Every single recommendation technique has its own advantages and disadvantages. The following recommendation techniques are promising for recommendations in OER: 1. Attribute-based recommendation, 2. User-based collaborative filtering and 3. Item-based recommendations.

1. Attribute recommendation techniques only take user- and item attributes into account for their recommendation. Attribute-based techniques are sensitive to changes in the profiles of the learners. They can always control the PRS by changing their profile or the relative weight of the attributes. A description of needs in their profile is mapped directly to available learning resources. A serious disadvantage is that an attribute-based recommendation is static and not able to learn form the network behaviour of the learners. That is the reason why highly personalized recommendation can not be achieved. Attribute-based techniques work only with information that can be described in categories. Attribute-based techniques can directly map characteristics of lifelong learners (like learning goal, prior knowledge, available study time) to characteristics of learning activities when these metadata are given.
2. Collaborative filtering techniques (or social-based approaches) use the collective behaviour of all learners or learning resources. Both user- and item-based techniques use the same mechanism of correlation for different objects. To underline the differences between these two techniques we now describe them together. User-based techniques correlate users by mining their (similar) ratings, and then recommend new items that were preferred by similar users.
3. Item-based techniques correlate items by mining (similar) ratings, and then recommend new, similar items. Main advantages of both techniques are that they use information provided bottom-up by user rating, that they are domain independent and require no content analysis, and that the quality of the recommendation increases over time [25].

User- and item-based techniques are useful for networks which are dealing with different topics (domains). They do not have to be adjusted for specific topics, which is important because we expect many LN for different topics. CF techniques can identify learning resources with high quality, allow learners to benefit from experiences of other, successful learners. CF techniques can be based on pedagogic rules that are part of the recommendation strategy. Characteristics of the current learner could be taken into account to allocate learners to groups (e.g., based on similar ratings) and to identify most suitable learning activities. For instance, suitable learning activities can be filtered by the entrance level that is required to study the learning activity. The prior knowledge level of the current learner would than be taken into account to identify the most suitable learning activity. To solve the cold-start problem, user- and item-based CF have to be combined with other CF techniques, like Atttribute based techniques, in a hybrid recommender system.

There is a need to combine techniques to increase the accuracy of recommendations. Using a combination of recommendation techniques is called a recommendation strategy [26]. Recommendation strategies use domain specific or history information about users or items to decide which specific recommendation technique provides the highest accuracy for the current user. For PRS in lifelong learning context it is not possible to simply take or adjust an existing PRS for consumer products (like in amazon.com). PRS for lifelong learning should support the efficient use of available resources to improve the competence development, taking into account the specific characteristics of learning. PRS have to be driven by pedagogical rules, which could be part of the recommendation strategy. The recommendation strategy looks for available data to decide on which technique(s) to select for which situation. The same situation is given when users are dealing with open educational resources for their competence development. In a first pilot of the navigation service the ISIS recommender system has been implemented. This recommender system used an attribute-based recommendation technique in combination wit an ontology based recommendation technique in a hybrid recommender system. The recommender system recommended the next best learning step to the learners from a pool of 17 learning resources.

4 Services for open educational practices

In the TENCompetence project we are developing a Personal Competence Manager (PCM) that will support individuals in building competencies. One important feature of this application is the underlying theoretical approach of learning networks. Learning networks should enable learners to develop their competencies together with peer-learners who have a similar competence development goal. Learners in learning networks are able to develop their own learning paths including the use of openly available resources and learning activities. Since all users in the TENCompetence environment will be able to share their learning paths and activities and resources they have used for competence building the environment should enable users to collect competence related information about open educational resources and educational/contextual metadata.

In addition the above described services can give a valuable contribution to help learners finding their way through open educational resources. Instead of using this service only for exemptions the similarity rate between a learner’s portfolio and documents in repositories can provide an individual "interestingness factor" for open educational resources. A high correlation between these resources and a portfolio can show that the learner already knows most of the concepts represented in these resources while a very low correlation would mean that these resources are completely out of the learners' context. While the positioning service takes only into account individual information of learners the navigation services uses also information by other learners to provide a recommendation.

For OER several situations would lead to different recommendation strategies. If a network of learners who use the content can be established the user behaviour can be taken into account to recommend best suited resources based on the items and the behaviour of the peer group of learners. If no user group information is available an item-based recommendation could be the best solution to recommend objects in distributed repositories although it might be computationally “expensive” to use an item-based recommendation with such a high number of objects. Since the learner groups of open educational resources are already available there is a need for a technology that connects these distributed learners and helps them with their competence development.

5 Discussion and Outlook

This paper has introduced positioning and navigation as two wayfinding services that haven been built in the framework of the TENCompetence project. We believe that the combination of prior knowledge analysis and a personal recommender system has a high potential to bridge the gap between the distributed resources and distributed self-directed learners who have the burden to choose suited learning activities and resources. Both services haven been recently analyzed in user studies and first results of these studies are promising. But this approach has also some issues: The use of Latent Semantic Analysis is limited to highly textual domains. In addition LSA can only find a similarity when the concepts used by the learners are represented in the semantic space. But there are several special presentation types (forms, descriptions of experimental designs etc.) that show an inherent higher prior learning than the purely textual content can show. In this case domain experts can deduct this but LSA cannot.

For the navigation service the use social based approaches like collaborative filtering techniques is limited by a number of disadvantages. New users first will have to give a sufficient amount of ratings to items in order to get accurate recommendations based on user-based CF (new user problem). New items have to be rated from a sufficient amount of users to be recommended (new item problem). Another disadvantage for CF techniques is the sparsity of past user actions in a network. Since these techniques are dealing with community driven information, they support popular taste stronger than unpopular. Learners with unusual taste may get less qualitative recommendations, and others are unlikely to be recommended unpopular items (of high quality).

In the future we will implement and test our services in several settings where open educational resources are used for competence development, specifically in the OpenER project of the Open University of the Netherlands where learning resources from the Open University are published under an open content license.

References:

[1] Duffy, T. & Jonassen, D. (1992). Constructivism and the Technology of Instruction: A Conversation. Hillsdale, NJ: Lawrence Erlbaum.
[2] Lave, J., and Wenger, E., eds. 1991. Situated Learning: Legitimate peripheral participation. Cambridge University Press.
[3] Gergen, K. J. (1999). An Invitation to Social Construction. Sage Publications: London.
[4] New Media Consortium (Ed.) (2007). The 2007 Horizon Report. ISBN 0-9765087-4-5.
[5] Unesco (2002). Forum on the impact of Open Courseware for higher education in developing countries. Final report. Paris: Unesco.
[6] Geser, G. (Ed.). Open Educational Practices and Resources. OLCOS Roadmap 2012. Salzburg Research.
[7] Vygotsky, L.S. (1978). Mind and society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.
[8] IEEE LTSC (2002). IEEE Standard for Learning Object Metadata. 1484.12.1-2002.
[9] Foroughi, R. (2004). Proposing New Elements for Pedagogical Descriptions in LOM. In: Uskov, V. (Ed.). Proceedings of the 7th IASTED International Conference on Computers and Advanced Technology in Education, August 16-18, 2004, Kauai, Hawaii, USA. Acta Press. 328-332
[10] Barton, J., Currier, S. & Hey, J. (2003) Building quality assurance into metadata creation: an analysis based on the learning objects and e-prints communities of practice, DC-2003 Proceedings of the International DCMI Metadata Conference and Workshop, September 28-October 2, 2003, Seattle, Washington USA, pp. 39-48.
[11] Mason, J. & Sutton, S. (2005). Dublin Core Metadata Initiative Education Working Group. Draft Proposal.
[12] Open Archive Initiative (Ed.) (2002). The Open Archives Initiative Protocol for Metadata Harvesting v 2.0.
[13] van Assche, F., Duval, E., Massart, D., Olmedilla, D., Simon, B., Sobernig, S., Ternier, S. & Wild, F. (2006): Spinning Interoperable Applications for Teaching & Learning using the Simple Query Interface, Journal of Educational Technology & Society, 9(2).
[14] Koper, R. & Specht, M. (2007). TenCompetence: Lifelong Competence Development and Learning. In: Sicilia, M.-A. Competencies in Organizational E-Learning. IDEA Group: Hershey, USA.
[15] Merrifield, J., McIntyre, D., & Osaigbovo, R. (2000), Mapping APEL: Accreditation of Prior Experiential Learning in English Higher Education. London. Retrieved July 1, 2006 from http://www.dfes.gov.uk/dfee/heqe/let_final.pdf
[16] Landauer, T. K., Foltz, P. W., & Laham, D. (1998). Introduction to Latent Semantic Analysis. Discourse Processes, 25, 259-284.
[17] Foltz, P., Laham, D. & Landauer, T. (1999). Automated Essay Scoring: Applications to Educational Technology. In *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 1999* (pp. 939-944). Chesapeake, VA: AACE.
[18] Steinhart, D. J. (2001). Summary Street: An intelligent tutoring system for improving student writing through the use of latent semantic analysis. http://lsa.colorado.edu/papers/daveDissertation.pdf
[19] Wiemer-Hastings, P., & Graesser, A.C. (2000). Supporting composition feedback with LSA in Select-a-Kibitzer. Interactive Learning Environments, 8, 149-169.
[20] Wolfe, M. B. W., Schreiner, M. E., Rehder, B., Laham, D., Foltz, P. W., Kintsch, W., Landauer, T. K. (1998). Learning from text: Matching readers and texts by Latent Semantic Analysis. Discourse Processes, 25, 309-336.
[21] Dessus, P. (2004). Simulating Student Comprehension with Latent Semantic Analysis To Deliver Course Readings from the Web. Cognitive Systems, 6(2-3), 227 – 237.
[22] Good, N., Schafer, J. B., Konstan, J. A., Borchers, A., Sarwar, B., Herlocker, J., & Riedl, J. (1999). Combining collaborative filtering with personal agents for better recommendations. Proceedings of AAAI, 99, 439-446.
[23] Melville, P., Mooney, R. J., & Nagarajan, R. (2002). Content-boosted collaborative filtering for improved recommendations. Proceedings of 18th National Conference on Artificial Intelligence (pp. 187-192). 28.07 – 01.08.2002, Edmonton, Alberta, Canada
[24] Soboro, I. M., & Nicholas, C. K. (2000). Combining content and collaboration in text filtering. Proceedings of the IJCAI Workshop on Machine Learning in Information Filtering (pp. 86-91). August 1999, Stockholm
[25] Herlocker et al. (2004): Evaluating Collaborative Filtering Recommender Systems. In: ACM Transactions on Information Systems, Vol. 22, No. 1, January 2004, Pages 5–53

[26] Drachsler, H., Hummel, H. G. K., & Koper, R. (2007). Recommendations for learners are different: Applying memory-based recommender system techniques to lifelong learning. Proceedings of Workshop on Social Information Retrieval for Technology-Enhanced Learning (SIRTEL'07), 2nd European Conference on Technology Enhanced Learning (EC-TEL'07). September 17-20, Crete, Greece

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