

Navigation Support for Learners in Informal Learning Environments

Citation for published version (APA):

Drachler, H., Hummel, H., & Koper, R. (2008). Navigation Support for Learners in Informal Learning Environments. *Default journal*.

Document status and date:

Published: 21/07/2008

Document Version:

Peer reviewed version

Document license:

CC BY-NC-ND

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

<https://www.ou.nl/taverne-agreement>

Take down policy

If you believe that this document breaches copyright please contact us at:

pure-support@ou.nl

providing details and we will investigate your claim.

Downloaded from <https://research.ou.nl/> on date: 15 Jul. 2023

Open Universiteit
www.ou.nl



Navigation Support for Learners in Informal Learning Environments

Hendrik Drachsler

Educational Technology
Expertise Centre

Open University of the Netherlands
PO-Box 2960, 6401 DL Heerlen
Tel: 0031-(0)45-576-2218
hendrik.drachsler@ou.nl

Hans Hummel

Educational Technology
Expertise Centre

Open University of the Netherlands
PO-Box 2960, 6401 DL Heerlen
Tel: 0031-(0)45-576-2651
hans.hummel@ou.nl

Rob Koper

Educational Technology
Expertise Centre

Open University of the Netherlands
PO-Box 2960, 6401 DL Heerlen
Tel: 0031-(0)45-576-2657
rob.koper@ou.nl

ABSTRACT

This paper offers an extended abstract of a PhD project that focuses on supporting learners in finding most suitable learning activities in informal learning environments. For this purpose we aim to develop a personal recommender system, which will recommend most suitable learning activities to learners regarding their personal needs and preferences.

As a theoretical framework for informal learning environments we use the concept of Learning Networks [1]. Learning Networks can be filled with lots of learning activities stemming from different providers. Such networks are dynamic, because each member could add or delete content at any time. A personal recommender system is needed to support learners in selecting learning activities from a Learning Network that will enable them to achieve their learning goals in a specific domain.

It is expected that such support will minimize the amount of time learners need for finding suitable learning activities. A better alignment of the characteristics of learners and learning activities is expected to increase both effectiveness and efficiency of learning progress of the learners.

Categories and Subject Descriptors

H.3.3 [Information Search and Retrieval]: *Information filtering*, H.3.5 [Online Information Services]: *Web-based services*, J.4 [Social and Behavioral Sciences] *Sociology*, K.3 [Computer and Education] *General*

General Terms

Measurement, Design, Experimentation, Human Factors

Keywords

Technology Enhanced Learning, Informal Learning, Learning Networks, Recommender Systems, Ontology, Collaborative Filtering

1. INTRODUCTION

Learning can roughly be distinguished into formal and informal learning [2]. Formal learning includes learning offers from universities or schools. It is highly structured, leads to a specific accreditation and has domain experts that guarantee quality. Informal learning happens to everybody from daily life activities related to work, family or leisure, it is less structured (in terms of learning objectives, learning time or learning support), and it does

not lead to a certain accreditation. The importance of informal learning is considered to achieve the knowledge society through lifelong learning [3], but the focus of learning remained on formal provision, qualifications and accountability [4]. This may change because the lifelong learners get support through the increasing amount of Web 2.0 services as content providers and by the Learning Networks project¹ as technology provider [1]. Learning Networks addresses informal learning issues and provides an infrastructure for distributed learners and stakeholders in certain domains.

The design of a Learning Network is learner-centered and its development evolves bottom up through the participation of the lifelong learners. The Learning Network approach focuses on the support of the neglected informal learning part that is becoming more important through the Web 2.0 development nowadays. It is in contrast to other learning environments, which are designed only top down, because their structure, learning resources, and learning plans are predefined by an educational institution or domain professionals (e.g., teachers). In Learning Networks, the lifelong learners are able to publish their own learning activities, or share, rate, and adjust learning activities from other learners. The learners are able to act in different roles (teachers, learners, or knowledge providers) in different Learning Networks in parallel. Therefore, the concept of Learning Networks has several things in common with the Web 2.0 development.

Web 2.0 also enables the users to add, share, rate, or adjust information. Popular services like *wikipedia.org*, *flickr.com*, or *youtube.com* benefit from that development and are proof of the change in interaction with the World Wide Web (WWW). The Web 2.0 technologies lifted the barrier of adding information to the WWW and enable much more users to contribute information to it. As a result, the amount of information available on the WWW increases dramatically. This has also an effect on Learning Networks, because most of the informal learning activities are based on contributions of learners and stored in the above mentioned Web 2.0 services. The learners may find it hard to get an overview of available learning activities and to identify the most appropriate learning activities.

Therefore, learners have a navigation problem in finding and selecting suitable information, like appropriate products to customers in e-commerce systems. The need to support users with the selection of information is becoming more important.

¹ www.tencompetence.org

Personal recommender systems [5] are becoming increasingly popular for suggesting tailored information to individual users. The main purpose of recommender systems on the WWW is to filter information a user might be interested in. For instance, the company *Amazon.com* [6] is using a recommender system to direct the attention of their users to other products in their collection. Existing 'navigation services' help to design and develop specific solutions for learners in informal Learning Networks. Though we have to consider the differences in the recommendation task of recommender systems for e-commerce and for informal learning. In the context of learning we have to consider that a learner has learning goals and wants to achieve a specific competence level in a certain time, whereas a customer using an e-commerce system wants to buy a product on a specific quality level in a specific price range [7].

This PhD project will treat the recommendation problem by addressing following question: How can we recommend suitable learning activities – regarding to the profile and history of learners – to reach the learning goals in a more efficient and effective manner?

2. CONTEXT OF WORK

One of the first recommender systems for Technology Enhanced Learning (TEL) was the Altered Vista system [8]. They used a collaborative filtering technique to explore how feedback provided by learners on learning resources can be stored and given back to a community. Similar research projects in the area of recommending learning resources to learners based on different kind of collaborative filtering techniques are the RACOFI system [9], the I-Help system [10], the QSIA system [11], and the CELEBRATE system [12]. A detailed overview about recommender systems in TEL can be found in [13]. Personalization through recommender systems is still an important issue in the TEL field. Many conference like the EC-TEL 2008² and workshops like SIRTTEL 2008³ are a proof of that.

Most of the recommender systems are applied in closed learning environments which represent the majority of current web-based learning environments. They are closed learning environments [14], because the learning content is described by an educational designer through semantic relationships. Many of these systems take advantage of Adaptive Hypermedia [15] technologies like metadata and ontologies to define the relationships, conditions, and dependencies of learning objects and learner models. Universities already hold well structured formal relationships like predefined learning plans (curriculum) with locations, known teachers and accreditation procedures. All this metadata can be used to recommend courses or personalize learning through the adaptation of the learning material or the learning environment to the students [16].

Learning Networks are more open in the sense that the learning activities and learning materials are added to the system during the lifetime of the community through mainly RSS or ATOM feeds. The absence of maintenance and predefined structure in informal learning is also called the 'open corpus problem' [14]. The open corpus problem applies when an unlimited set of

documents is given that cannot be manually structured and indexed with domain concepts and metadata from a community. The open corpus problem also applies to informal Learning Networks. Therefore, bottom up recommendation techniques like collaborative filtering are more appropriate because they require nearly no maintenance and improve through the emergent behavior of the community. In order to address the informal part of learning we have to consider different environmental conditions, the lack of maintenance and less formal structured learning activities. Learning activities in Learning Networks are mainly structured through tags and implicit or explicit ratings given by the learners.

In the world of consumer recommender systems, there are several data sets with specific characteristics (the *MovieLens* data set, the *Book-Crossing* data sets, or the *EachMovie* data set) available. These data sets are used as a common standard or benchmark to evaluate new kinds of recommendation algorithms [17-19]. In TEL there are neither standardized data sets nor standardized evaluation procedures available to evaluate recommender systems for learning. A recommender system for informal learning that takes into account specific learning demands also has to be evaluated by learning evaluation criteria. From an educational point of view, learners only benefit from learning technology when it makes learning more effective, efficient, or more attractive. Therefore, we suggest to mix recommender system evaluation criteria like accuracy, coverage and performance with educational research measures in order to evaluate their effects on Learning Networks.

For the above mentioned reasons, we have set up the following research proposal to address recommender systems in informal Learning Networks.

3. WORK DONE SO FAR

We set up a roadmap in order to run three studies with different foci. In these consecutive steps, three recommender systems are planned to study suitable recommendation techniques to finally meet the needs for a recommender system for informal Learning Networks (Figure 1). Study 1 (already carried out) was an experimental pilot in the domain of Psychology, study 2 will be a simulation with a multi-agent programmable modeling environment, and study 3 will be an experimental pilot in the domain of Open Educational Resources.

3.1 LITERATURE REVIEW

Before we started the experimental testing phase we did a literature research in order to discover related work and to define the recommendation task for a recommender system in informal Learning Networks. Further, we analyzed appropriate recommendation algorithm for informal Learning Networks that might serve the recommendation task [13].

3.2 PSYCHOLOGY PILOT

After defining the recommend task and analyzing some suitable algorithms we started the data gathering process within a first experiment. In this first study we applied a recommender system that was based on stereotype filtering algorithm and a domain ontology in an experimental Moodle environment [20]. For the stereotype filtering part we took into account successful completed learning activities by other learners as implicit ratings.

² <http://www.ectel08.org/>

³ <http://ariadne.cs.kuleuven.be/sirtel/>

Using an ontology was a top down approach, for future research we prefer to use bottom up techniques whenever possible because of the lack of maintenance in Learning Networks. The ontology was mainly used to cover the 'cold-start' problem of the recommender system. Therefore, we took advantage of the explicit association of the domain ontology in order to recommend learning activities when no collaborative filtering data was available. The recommendation was based on quantitative information about successful completions of activities by learners with similar preferences [21].

4. CURRENT CHALLENGES

4.1 SIMULATION STUDY

In the second study, we want to apply different kind of collaborative filtering techniques in order to evaluate their effects for Learning Networks with differently dense data sets and different amounts of learners. In general, Learning Networks are hugely compared to other educational portals, but they are small compared to the data sets that are used in classical recommender system research. For instance, most of the e-commerce data sets are quite densely filled with metadata and behavioral information of consumers. They easily exceed thousands of products and consumers with information about millions of transactions (ratings or user behavior). For the simulation study we want to apply implicit ratings drawn from the behavior of the learners from the first experiment and enrich them with additional educational Web 2.0 data. Therefore, we decided to use a multi-agent programmable modeling environment called Netlogo. Netlogo establishes the possibility to set up a simulation for Learning Networks that can support defining requirements before starting the costly process of development, implementation, testing and revision of recommender systems for that field. In this study we want to focus on recommendation techniques that require nearly no maintenance from domain experts like collaborative filtering techniques.

4.2 ADVANCED STUDY

The practical character of the first study, embedded in a formal course with real students who wanted to be accredited, excluded some of the navigational and motivational problems faced by informal learners. For the future research of Learning Networks we envision more informal learning activities without a formal assessment, therefore we are planning to have an additional experimental study where Open Educational Resources (OER) and their community are used. An experimental pilot with OER is more similar to Learning Networks, thus such a network could exist out of different mixed OER, formal learning offers, or separated learner contributions in once. In this pilot we intend to combine the most successful recommendation techniques from the previous research. Further, we want to evaluate user-based tagging and explicit rating mechanism as additional data source for a recommender system in informal Learning Networks.

5. CONTRIBUTIONS TO THE FIELD

It is quite early to speculate on the contribution of this PhD work. However, we wish to outline some potential that this work might offer.

In the first place, we contribute towards a definition for the recommendation task for a recommender system in informal learning. Further, we also want to identify required domain

knowledge that is required for recommending learning activities to learners. Secondly, we are planning to offer a kind of data set for recommender systems in informal learning after the end of our empirical studies. Such a data set might contribute towards standardization for the evaluation of recommenders in learning. Finally, we are interested how pedagogy rules like 'go from simple to complex' can be integrated into recommender system. Based on our early experience, we believe that recommendations for learners require deeper reasoning than other domains. Simple semantics like "People who liked X also liked Y" might be misleading for some TEL recommender systems. For recommender systems in TEL we might have semantics like "People who studied X, Y, and Z on competence level 3 and prior knowledge level 2 seem to have the same learning goal, thus we recommend studying W".

This work mainly attempts to make a contribution to the TEL field through discovering and recommending suitable learning activities with recommender system techniques to learners. But maybe the deeper reasoning approach also has an effect on recommender systems in other domains.

6. ACKNOWLEDGEMENTS

Authors' efforts were (partly) funded by the European Commission in TENCompetence (IST-2004-02787) (<http://www.tencompetence.org>).

7. REFERENCES

- [1] Koper, R. and Tattersall, C. New directions for lifelong learning using network technologies. *British Journal of Educational Technology*, 35, 6 (2004), 689-700.
- [2] Colley, H., Hodkinson, P. and Malcolm, J. *Non-formal learning: mapping the conceptual terrain*. University of Leeds, Lifelong Learning Institute, Leeds, 2002.
- [3] EU Commission A memorandum on lifelong learning. Commission of the European Communities, Brussels, 2000.
- [4] Coffield, F. *The Necessity of Informal Learning*. The Policy Press, Bristol, 2000.
- [5] Adomavicius, G., Sankaranarayanan, R., Sen, S. and Tuzhilin, A. Incorporating contextual information in recommender systems using a multidimensional approach. *ACM Transactions on Information Systems (TOIS)*, 23, 1 (2005), 103-145.
- [6] Linden, G., Smith, B. and York, J. Amazon.com recommendations: Item-to-item collaborative filtering. *IEEE Internet Computing*, 7, 1 (2003), 76-80.
- [7] Schafer, J. B., Konstan, J. and Riedl, J. Recommender systems in e-commerce. In *Proceedings of the 1st ACM conference on Electronic commerce (Denver, Colorado, 1999)*, ACM Press, New York, NY, 158-166
- [8] Recker, M. M., Walker, A. and Lawless, K. What do you recommend? Implementation and analyses of collaborative information filtering of web resources for education. *Instructional Science*, 31, 4 (2003), 299-316.
- [9] Anderson, M., Ball, M., Boley, H., Greene, S., Howse, N., Lemire, D. and McGrath, S. RACOFI: A Rule-Appling Collaborative Filtering System. In *Proceedings of the IEEE/WIC COLA'03 (Halifax, Canada, October, 2003)*.

[10] Tang, T. and McCalla, G. Beyond Learners' Interest: Personalized Paper Recommendation Based on Their Pedagogical Features for an e-Learning System. In Proceedings of the 8th Pacific Rim International Conference on Artificial Intelligence (PRICAI 2004), (Auckland, New Zealand, August 9-13, 2004), Lecture Notes in Computer Science, Springer, Berlin Heidelberg, 301-310.

[11] Rafaeli, S., Barak, M., Dan-Gur, Y. and Toch, E. QSIA: a web-based environment for learning, assessing and knowledge sharing in communities. Computers & Education, 43, 3 (2004), 273-289.

[12] Manouselis, N., Vuorikari, R. and Assche, F. V. Simulated Analysis of MAUT Collaborative Filtering for Learning Resource Recommendation. In Proceedings of the Workshop on Social Information Retrieval for Technology-Enhanced Learning (SIRTEL'07), 2nd European Conference on Technology Enhanced Learning (EC-TEL'07) (Crete, Greece, September 17-20, 2007), CEUR Workshop Proceedings Vol-307.

[13] Drachsler, H., Hummel, H. and Koper, R. Personal recommender systems for learners in lifelong learning: requirements, techniques and model. International Journal of Learning Technology, Special Issue on Learning Networks, 2008, (in press).

[14] Brusilovsky, P. and Henze, N. 2007. Open Corpus Adaptive Educational Hypermedia. In The Adaptive Web, Brusilovsky, P., Kobsa, A., Nejdl, W., Ed. Lecture Notes in Computer Science 4321, Springer, Berlin Heidelberg New York, 671-696

[15] Brusilovsky, P., Kobsa, A., Nejdl, W. The Adaptive Web. Springer, Berlin Heidelberg New York, 2007.

[16] Baldoni, M., Baroglio, C., Brunkhorst, I., Marengo, E. and Patti, V. Reasoning-Based Curriculum Sequencing and Validation: Integration in a Service-Oriented Architecture. In Proceedings of the EC-TEL 07 (Crete, Greece, 2007) Lecture Notes in Computer Science 4753, Springer, Berlin Heidelberg New York, pp. 426.

[17] Goldberg, K., Roeder, T., Gupta, D. and Perkins, C. Eigentaste: A Constant Time Collaborative Filtering Algorithm. Information Retrieval 4(2), 133-151.

[18] O'Sullivan, D., Wilson, D. and Smyth, B. Improving Case-Based Recommendation A Collaborative Filtering Approach. In Proceedings of the 6th European Conference on Case-Based Reasoning, ECCBR (Aberdeen, Scotland, UK, 2002). Lecture Notes in Computer Science 2416, Springer, Berlin Heidelberg New York, 73-90

[19] Sarwar, B. M., Karypis, G., Konstan, J. and Riedl, J. Recommender systems for large-scale e-commerce: Scalable neighborhood formation using clustering. In Proceedings of the Fifth International Conference on Computer and Information Technology (2002), IEEE Computer Society Washington, DC, USA 158-167.

[20] Dougiamas, T. Moodle. <http://moodle.org>, 2007.

[21] Drachsler, H., Hummel, H., Bert, v. d. B., Jannes, E., Adriana, B., Rob, N., Wim, W., Nanda, B. and Rob, K. Effects of the ISIS Recommender System for navigation support in self-organized Learning Networks. In Proceedings of the 1st Workshop on Technology Support for Self-Organized Learners (TSSOL08) in conjunction with 4th Edumedia Conference 2008 on Self-organized learning in the interactive Web – Changing learning culture? (Salzburg, Austria, June, 2-3, 2008). CEUR Workshop Proceedings Vol-349.

Figures

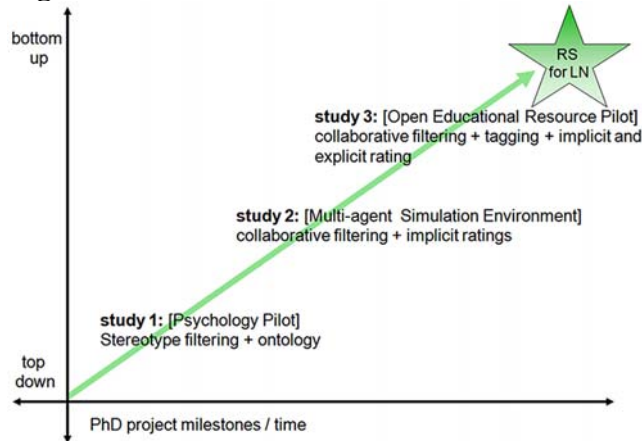


Figure 1: Roadmap for the development of a personal recommender system for Learning Networks

© ACM, (2008). This is the author's version of the work. It is posted here by permission of ACM for your personal use. Not for redistribution. The definitive version was published in Doctoral Symposium at ACM Recommender Systems 2008. October, 23-25, 2008, Lausanne, Switzerland

Overview of learning activities		
<p>You already completed: You have not completed any learning activity.</p>	<p>Activities you are enrolled into: Perception Personality Awareness Changes during the life time Therapies Language</p>	<p>You still need to complete: Behavior and health Thinking Social Psychology Conditioning and learning Abnormal psychology Recall and neglect Intelligence The biology of behavior Motivation and emotions Attention and awareness Applied Psychology</p>
<p>Based on your study interest in "cognition" (mentioned in your personal profile), we suggest to further study the following learning activity:</p>		
Title of the suggested learning activity		Options
Thinking		description of the recommendation adjust profile

Figure 2: The Moodle learning environment with the implemented recommender system. Based on the enrolled courses and the interest of the learner in ‘cognition’, the recommender system suggests a learning activity about ‘Thinking’ as the next most suitable one.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.