THE FURTHER EDUCATION USING ONTOLOGY FOR E-LEARNING PERSONALIZATION

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KEYWORDS

Ontology, socionics, e-learning, personalization, further education

ABSTRACT

One of the most important prerequisites in base plan for long-term development of all countries is high education level in society what includes e-learning studies. Learning is a cognitive activity that differs from person to person. Most of the e-learning systems do not take into account individual aspects of person, ignoring the different needs that are specific to existing cognitive profiles. The goal of the paper is to work out and create theoretical principles of using ontology for building course methodology for individual use, according to the person's characteristics and performance, depending also on the concepts that the person knows. The objectives of the paper are ICT ontology and basic theory of socionics in e-learning. As the result of this technology should be recommendations of methodology of delivering course units for each individual person using e-learning.

INTRODUCTION

Personalization is the next step in the evolution of e-learning systems. Different type of persons can have several cognitive styles; witch makes the efficacy of an e-learning system different with distinct person.
The research idea is to get main information from individual text document and use ontology for finding the main characteristics for purpose to give course content for individual person in the best way. The problem considered in this paper is – how to investigate distributed two-way tagging services as a self-evolving infrastructure, which would allow to share and reuse the knowledge of developers of e-learning materials.

Knowledge management includes acquiring or creating knowledge, transforming it into a reusable form, retaining it, and finding and reusing it. There is an important change of educational focus from remembering large amounts of knowledge to ability to solve problems and quickly find necessary information. It makes important influence for changing learning methods from traditional lectures and presentation materials to active use and structure of information. Growing importance of learning games, analysis of situations and research will take part in learning methods (see Cakula 2001). E-learning courses have to serve various learner groups and can be presented in many different forms. There are novice learners, intermediate and advanced up to experienced students. Furthermore, e-learning courses can be attended by dependent or independent learners who study full-time or part-time. On the other hand e-learning is based on certain prerequisites, such as management, culture, and IT (see Maurer et.al. 2001). Abreast evolution IT and Web technologies e-learning acquires a great popularity – it is useful in tertiary education, e.g. universities, also in lifelong learning scope.

A personality type is the structure of the collective unconscious which guides the physical, psychological, social and personal interaction of informative manifestation. Interaction between the person and the environment (character, behaviour, thinking and action) directly depends on the structure of one's psyche (see Stratijevska). Socionics is a science dealing with the study of person's psyche from the moment information has been received, during the processing stage to its final transmission. It helps to understand what one can expect and require from other person; it also helps to understand why he or she acts in a certain way and what his or her weak points are.

Text document as an information source must comprise five different parts: personal, personality, cognitive, pedagogical and preference data. As the result of this technology should be recommendations of methodology of delivering course units for each individual person using e-learning.

TERMS AND DEFINITIONS

Authors of this paper are using some specific terms. It is significant to arrange about meaning terms used through presented paper.

Definition 1 Knowledge item – is a material in textual format used in e-learning.

Definition 2 Knowledge management – comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences.

Definition 3 Ontology – is a formal representation of knowledge as a set of concepts within a domain, and the relationships between those concepts. It is used to reason about the entities within that domain, and may be used to describe the domain.

Definition 4 Domain ontology – allow specifying formally and explicitly the concepts that appear in a concrete domain, their properties and their relationships.

Definition 5 Socionics – is a theory of information processing and personality type, distinguished by its information model of the psyche and a model of interpersonal relations.

Definition 6 Superconcept Formation System (SFS) is a learning-based matching algorithm with rule-based enhancements.

Definition 7 eLAMs are e-learning analysis models.

BASIC PRINCIPLES OF SOCIONICS

Socionics is a new branch of practical psychology and a theory helping to understand every individual, so the use of its conclusions can facilitate the achievement of goals of an educational institution. Teachers and students use socionics in order to make the education process more productive and exciting (see Myers 1998).

All people can be divided into 16 groups, or socionic types. All 16 types can be divided into 4 groups, or quadras. People belonging to one and the same group understand each other very well, have similar opinions, attitudes, etc. If a person joins another group, he or she has to face different opinions and moral norms.

In socionics, which is based on Carl Gustav Jung's theory of psychological types, an individual is characterized, sorting their psychological differences into four opposite pairs, or dichotomies:

1) **Introversion (I)** vs. **Extraversion (E)**, which identify the energy drawing function;

2) **Sensing (S)** vs. **Intuition (N)**, which identify the information gathering (perception) function;

3) **Thinking (T)** vs. **Feeling (F),** which identify the decision-making function;

4) **Judging (J)** vs. **Perceiving (P),** which identify person's lifestyle (planned or spontaneous) (see Mikelsone 2004).

Combining characteristic features, we get 16 four-letter codes, e.g. ENFJ, ISTP etc. denoting a specific sociotype.

The developed model of person's psyche shows the order of the flow of information in one's psyche. From this order also depends how people (different socionic types) interact, i.e. whether they understand each other or not; whether they understand the material or not, etc.

In every lecture-room, there must be persons with the same type of qualities dominating. In such a case, the understanding of sociotypes and their peculiarities can help to find the optimum teaching and learning method because the value of socionics is determined by its forecasting possibilities.

Establishing a link between socionics and adult education processes, it would be possible to help each person to find the most appropriate type of training, as well as to understand the causes of past mistakes and failures.

E-LEARNING METHODOLOGY

Learning in an invisible-classroom setting promotes unlimited access to information. It can also take away social and physical boundaries (like shyness, gender, race, location, etc.), leaving everyone on a more equal footing for learning.

An e-learning system is a great way of cooperation with allow-citizens, simultaneously profiting from customers or other people interested in.

Communication in education has most often emphasized one-way transmission. However, in higher learning, communication should focus on whether the concept or application is reasonable or suitable based on the particular situation.

Learning is not used only in sense of formal curriculum, but in the sense of everyone accessing information, cultural resources or entertainment in order to develop as individuals.

People learn in different ways and require a variety of stimuli to engage them in the learning process. It is necessary to remove barriers to access; cater for individual learning styles (not just ages); create exciting environments; use innovative methods; value learning experts, consult with users and reach out to new users.

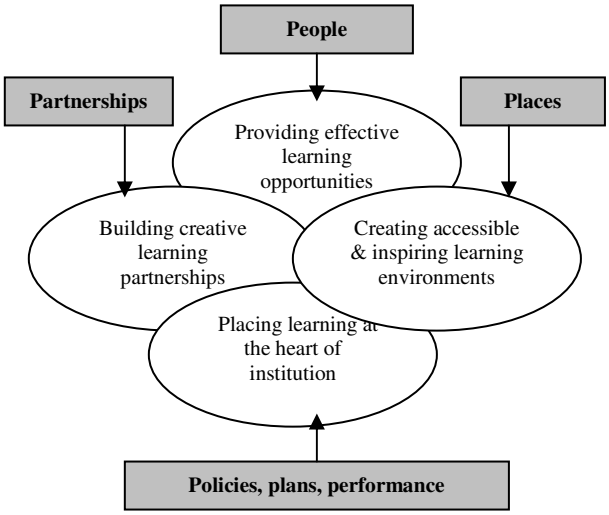

Figure 1. Inspiring Learning for All (see Brindley 2005).

Understanding the characteristics of "Invisible Students" is an important aspect of the online learning environment. Only recently has this topic been widely discussed. Distance learners can be characterized as dynamic individuals whose characteristics often change in response to both educational and life experiences (Gibson 1998). The main difference among students is in their learning styles. A learning style is the way in which the learner receives and interacts with instruction and responds to the learning environment. Educators should remember the connection between national cultures and learning styles, i.e., some learning styles are more or less likely to be found among individuals from a particular culture.

As a result of the work, an individual-oriented learning process model for adults will be obtained to stimulate acquisition of skills and knowledge. Analysing the model data, it would be better to identify the type of training most suitable for the adult's individual personality type to avoid a situation when the trainee and the trainer cannot find a common language. People differ in their appearance; also their perception of events and the surrounding world is very different (Mikelsone 2004). From the point of view of socionics, it is interesting to understand the differences between adults.

The long-term goal of research is to develop a content oriented, knowledge, and meaning-based computational framework to form the ontological basis of the e-learning domain. In this paper, we focus on investigating the method and process to develop such an ontological basis.

FROM DATA TO KNOWLEDGE MINING

Most past approaches to data mining have been based on association rules. Any engineering field creates artifacts such as products or processes. During an artifact's life cycle a great deal of data is produced, starting with an initial set of specifications and continuing through maintenance reports. Many of these documents are textual. Data management technology has evolved and has provided the means for organizing and storing information. Having information available is a necessary, but not sufficient, condition for learning. People must be able to retrieve and digest information to craft new knowledge from the stored information. Decision-making processes improve whenever successful and unsuccessful cases are understood, revealing flawed decision patterns that should be avoided (see Maher & Garza, 1995; Soibelman & Kim, 2000).

In general, ontology can be used as a sophisticated indexing mechanism to structure an information repository such as unstructured documents in text retrieval systems (see Uschold & Gruninger, 2004). Attempts have been made to develop ontology-based algorithms to achieve high precision and high recall through concept disambiguation and query expansion by utilizing the semantically related concept space of the ontology. Using ontologies allows strong semantics to be applied to the individual paragraphs, sentences, and words of the documents to be indexed (see Mayfield, 2002). The correlations among concepts defined in ontology also enable navigation and browsing of query-related documents.

Knowledge-related work is characterized by high level of diversity and requires a high degree of skills and expertise. Knowledge, as a resource, must be constantly reviewed. The main training direction is connected with individual approach to the audience, based on fundamental principles of socionics and the ability to distinguish personality types. Text document as an information source must comprise five different parts: personal, personality, cognitive, pedagogical and preference data. Each one is an aggregation of person characteristics, which are not usually changed during an e-learning session.

Personal data comprises the biographical information about the student, and can be easily obtained from the course enrolment form. This information is:

- Person's name;
- Special accessibility needs to course materials that the person must have;
- Affiliation;
- Person's professional activities;
- List of degrees and qualifications;
- Information of student security and access credentials.

The personality data models the person's characteristics that represent the type of person. These characteristics

can be inferred from personality tests. (Webster 2004) The attributes of personality data are:

- Personality type;
- Concentration skills, based on the average time spent in the learning contents;
- Collaborative work skills based on the participation in group works;
- Relational skills based in the interactions with students and teacher.

The cognitive data models the student characteristics that represent the type of cognition the student possesses. These characteristics can be inferred from cognitive tests. (Souto 2003) This information is:

- Cognitive style;
- Level of experience the student possesses in using the e-learning system;
- Student experience in using computers.

The pedagogical data defines the student characteristics that deal directly with the learning activity. This data intends to model the student's behaviour in learning situations, comprising two strictly personal properties:

- Learning style;
- Learning approach.

The pedagogical data also includes three more operational properties:

- Course objectives: list of concepts that the student must learn in the session course;
- Course evaluation: defines if the student is taking an evaluated course or not;
- Course navigational control: defines what type of control is being used in content navigation.

The preference data stores a set of student preferences regarding the system customization. Most of the preferences are gathered from the student, but some of them are defined by the system administrator. The attributes of preference data are:

- Preferred presentation format;
- Preferred language for content display;
- Web-design personalization;
- Command personalization;
- Personal notebook;
- Sound volume;
- Video speed;
- Subtitles.

This proposes an ontology-based framework for establishing personalized learning objects retrieval. In the proposed framework, Domain Ontology is used for constructing automatic inferring of user intention. The personalization functionality is provided by the probabilistic semantic inferring of user intention and user preference. An ontology query expansion algorithm and an integrated learning objects recommendation algorithm are proposed. Focused on digital learning material and contrasted with other traditional keyword-based search technologies, the proposed approach has shown significant improvement in retrieval recall precision rate, and recommendation performance. (Ming Che Lee 2007)

DOMAIN ONTOLOGY

Ontologies allow specifying formally and explicitly the concepts that appear in a concrete domain, their properties and their relationships. Furthermore, they are useful in many environments: and especially in educational environments, as they enable people and/or software agents to share a common understanding of the knowledge structure. Moreover, they permit to reuse knowledge, that is to say, it is not necessary to develop ontology from scratch if ontology is available for use in the modeling of the current domain.

Ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them.

Why would someone want to develop ontology? Some of the reasons are:

- To share common understanding of the structure of information among people or software agents
- To enable reuse of domain knowledge
- To make domain assumptions explicit
- To separate domain knowledge from the operational knowledge
- To analyze domain knowledge

Domain ontology is to describe learning materials that compose a course, capable of providing adaptive e-learning environments and reusable educational resources.

AN ONTOLOGY MATCHING ALGORITHM

According to the classification in (Doan and Halevy 2005), most schema matching techniques can be divided into two categories: rule-based and learning-based. The former considers schema information only, and different algorithms distinguish from each other in their specific rules; while the latter considers both schema information and instance data, and various kinds of machine learning techniques have been adopted.

Most existing rule-based algorithms make use of human heuristics and/or domain knowledge to predefine these weights. Moreover, once weights are determined, they are unlikely to be updated, or at most by trial-and-error.

Learning-Based Ontology Matching presents an ontology matching approach based on probability theory by

exchanging instances of concepts. During each step of the matching process, the likelihood that a decision is correct is taken into account. No domain knowledge is required, and the ontology structure plays no role (Wiesman and Roos 2004).

Superconcept Formation System is based on the above insights, authors propose a learning-based matching algorithm combined with rule-based techniques. This approach overcomes the two Jingshan Huang and Michael N. Huhns listed disadvantages:

1) adopt machine learning techniques to avoid predefined weights;
2) learning technique is carried out based on schema information alone to avoid the difficulty in getting instance data.

When ontologies are characterized by the typical aspects of concept names, concept properties, and concept relationships, then these aspects contribute differently to the meaning of a concept. It is thus essential to assign different weights to the aspects. For learning-based matching algorithms, the main problem is the difficulty in getting enough instance data of sufficient quality.

Notice that because schemas have many more varieties than instance data, our approach is significantly more challenging than most other learning-based ones. Each superconcept consists of concepts from different ontologies that are equivalent to each other. (see Huang 2005)

USING OF ONTOLOGY, ARCHITECTURE AND TECHNOLOGIES IN MODEL

Today, simulations are being used in educational and corporate training environments as tools to help develop the competencies that improve the performance of business professionals, etc. There are many terms for online education. Some of them are: virtual education, Internet-based education, web-based education, and education via computer mediated communication.

Ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them. Ontology is therefore a controlled, hierarchical vocabulary for describing a knowledge system. It abstracts the essence of concepts, and allows distinguishing various kinds of objects and defining the relationships among them. Ontology, like a data base schema, is a knowledge level description (Heijst 1995) in that it is independent of any representational formalism.

Ontology development is different from designing classes and relations in object-oriented programming. Object-oriented programming centers primarily around methods on classes. A programmer makes design decisions based on the operational properties of a class, whereas an ontology designer makes these decisions based on the structural properties of a class. Individual instances are the most specific concepts represented in a knowledge base.

When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse. This set of objects, and the describable relationships among them, are reflected in the representational vocabulary with which a knowledge based program represents knowledge. Formally, ontology is the statement of a logical theory.

Support system for modeling and control of the continuous, as well as discrete event systems has been described. The database of the system contains methods and tools for modeling and control synthesis. Further, the database contains complete models of some systems specified by attributes. Students not only can learn which methods are proper for which systems and modeling and control requirements, but they also can use various tools to simulation of a given task.

Our primary foundation is based upon the concept that e-learning analysis models are knowledge-based abstractions of physical systems, and therefore knowledge sharing is the key to exchanging, adapting, and interoperating eLAMs within or across institutions.

To enable robust knowledge sharing, we propose a formal set of ontologies for classifying analysis modeling knowledge. To this end, the fundamental concepts that form the basis of all e-learning analysis models are identified, described, and typed for implementation into a computational environment.

Although capturing eLAM knowledge in a well-designed ontology structure is expected to facilitate reusing, adapting, and exchanging analysis models, the captured knowledge is of very limited utility unless it can be easily brought to bear on real engineering analysis problems.

The former methods should be based on characteristics of the captured eLAM knowledge associated with models using the ontology structure, while the latter methods are based on characteristics of different user classes. To support this, a user ontology structure could be implemented as part of our system. In this scheme users would be classified based on analysis experience level, underrepresentation, and ethnic group.

Refinements based on this study will enable us to maximize the effectiveness of our eLAM knowledge base environment for a diverse mix of users.

CONCLUSIONS

In today's changing socio-economic circumstances, the need for self-development becomes more and more crying. This is a moment when we have to be brave and active.

People more than ever try to use a maximum of their skills and possibilities, be successful in their professional life or some other area creatively using their experience and knowledge; they are open to new opportunities and innovations.

Only an innovative approach, full use of opportunities provided by the increasing knowledge potential, transformation of traditional procedures, using the opportunities of ICT in each and every sector and work, presents a new way of thinking and mode of action.

Educational content and training sites will be adapted to individual's requirements after a consultation about the most effective site preparation solutions and the most relevant training techniques for each personality type. There is no good or bad type, no right or wrong choice; however, every person can belong to just one type.

Adults must be offered:

- emphasis on non-academic training (interesting and useful free time exercises);
- Sharing examples of best practice (why? what? how?);
- Individual approach to the personality development and meeting one's desires.

In this paper we have proposed domain ontology to describe learning materials that compose an adaptive course. We have considered two interesting aspects; namely, the learning style more adequate for an educational resource and the device that best uses it.

The inclusion of the learning style in the description of the learning objects enables that an e-learning system compares the user's learning style with the resources learning style possibilities. This way, the learning materials that best fit the student's individual requisites are dispatched.

If we would like to use ontology matching we have to know that both rule-based and learning-based algorithms have disadvantages, so we propose SFS, a learning-based algorithm integrated with rule-based techniques.

Combining ontology usage for e-learning personalization with the analysis of person's character, behaviour, thinking and action, it is possible to radically change our learning style, it can help inhabitants become more active and self-confident, thus becoming catalysts of the development of institutions.

ICT and an individual approach in education develop the creative skills and improve the training efficiency. ICT can directly influence such key future success factors as creativity and the innovation skill, which are the main resources of competitiveness and growth.

From the results of research and author's conclusions, it follows that the training system must more actively deal with the assessment, change and improvement of individual's skills and behaviour, for it is a tool for raising inhabitant's satisfaction and the quality of life.

REFERENCES

A. Doan and A. Y. Halevy. Semantic integration research in the database community: A brief survey. AI Magazine, 26(1):83–94, 2005.

Bechhofer S., van Harmelen F., Hendler J., Horrocks I., McGuiness D. L., Fatel-Schneider P. F., Stein L. A., *OWL Web Ontology Language Reference. W3C Recommendation*, 2004

Bloehdorn S. and Hotho A. Boosting for Text Classification with Semantic Features, In Proceedings of the Workshop on Mining for and from the Semantic Web at the *10th ACM SIGKDD Conference on Knowledge Discovery and Data Mining* (KDD 2004), 2004

Brindley Lynne, the British Library and E-Learning, *IFLA Journal 31:13*, 2005.

Cakula S., *Information technologies in the research work at Vidzeme University College as a means of formation of students creative experience*, Latvijas Zinātņu Akadēmijas Vēstis, 2001, 55.sēj, 1./2., p. 33. – 41.

Dumais S. and Chen H., Hierarchical Classification of Web Content, In Proceedings of the *23rd Annual International ACM SIGIR Conference on Research and Development in Information retrieval,* 2000.

F. Wiesman and N. Roos. Domain independent learning of ontology mappings. In Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS 04), New York, NY, July 2004.

Fernandez-Caballero, A., Gascuena, J.M., Botella, F. & Lazcorreta, E. (2005) "Distance learning by intelligent tutoring system. Part I: Agent-based architecture for user-centred adaptivity". *Proceedings of the 7th International Conference on Enterprise Information Systems, vol. 5*, pp. 75-82.

Gibson, C. C. (1998). Distance learner in higher education: Institutional response for quality outcome. Madison, *WI: Atwood Publishing,* 117-124.

Golder S.A. and Huberman, B.A. The Structure of Collaborative Tagging Systems, *Journal of Information Science,* 32(2), 2006, pp.198-208.

Heijst, G., "The Role of Ontologies in Knowledge Engineering", PhD. Thesis, University of Amsterdam, Netherlands, 1995.

Huang, J., Zavala, R., Mendoza, B., and Huhns, M.N.: Reconciling Agent Ontologies for Web Service Applications. In: Proceedings of Multiagent System Technologies: *Third German Conference (MATES 05). Springer Verlag,* Berlin (2005).

Krithara A., Semantic Classification. Hewlett-Packard Labs technical report: Hewlett-Packard Labs, HPL-2004-182, 2004

Maher, M.L., & Garza, A.G.S. (1997). Case-based reasoning in design. IEEE Expert: Intelligent Systems and Their Applications 12(2), 34–41.

Maurer H. and Sapper M., E-learning has to be seen as part of general knowledge management, *Proceedings of ED-MEDIA World Conference on Educational Multimedia, Hypermedia & Telecommunications,* 2001.

Mayfield, J. (2002). Ontologies and text retrieval. *The Knowledge Engineering Review 17(1),* 71–75.

MBTI Manual. A Guide to the Development and Use of the Myers-Briggs Type Indicator (3rd ed.). Isabel Briggs Myers, Mary H. McCaulley, Naomi L. Quenk, Allen L. Hammer. *Consulting Psychologists Press*, Inc. Palo Alto, California, 1998, p. 420. ISBN 0-89106-130-4.

Mikelsone L.V. Nepārveido sevi, tikai uzzini, kas esi. Rīga, 2004, ISBN 9984195775, p. 255.

Ming Che Lee, A Semantic-Aware Framework for Personalized Learning Objects Retrieval and Recommendation. National Cheng Kung University, Taiwan, 2007.

Pavel S., Jerome E. Ten challenges for ontology matching, Technical Report # DISI-08-042, August 2008.

Shirky, C. (2007). Ontology is overrated: categories, links, and tags. Accessed at http://shirky.com/writings/ontology_overrated.html

Soibelman, L., & Kim, H. (2000). Generating construction knowledge with knowledge discovery in databases. Proc. *8th Int. Conf. Computing in Civil and Building Engineering (VIII-ICCCBE),* Stanford, CA.

Souto, M.A.M., et al., Towards an Adaptive Web Training Environment Based on Cognitive Style of Learning: an Empirical Approach. 2003.

Stratijevska V. Kā rīkoties, lai mēs nešķirtos. ISBN 97899849938, p. 320.

Uschold, M., & Gru¨ninger, M. Ontologies and semantics for seamless connectivity. *SIGMOD Record 33(4),* 58–64. (2004).

Wang B., McKay R., Abbass, H.A., Barlow, M., A Comparative Study for Domain Ontology Guided Feature Extraction. In Proceedings of the *26th Australasian computer science conference,* Vol. 16, 2003.

Webster, R., Metacognition and the Autonomous Learner: Student Reflections on Cognitive Profiles and Learning Environment Development, *in ICED 2004*. 2004.

Witten I.H., Frank E., *Data Mining: Practical Machine Learning Tools and Techniques (Second Edition)*, Publisher: Morgan Kaufmann, 2005

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