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Learner profiles and the process of Learning in the Higher Educational Context

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Abstract: This paper presents a general review of methods for extracting, and using Learner profiles in Higher Education (HE) Informatics. Our research mainly examines the process of Learning in the Higher Educational Context. We review educational and technological aspects, and presents issues related to Technology Enhanced Learning, Personalization, and Adaptive Learning environments. Eventually, we examine different methods for extracting learners' profiles encountered in the Greek HE context, and emphasize on issues concerning the design of accessible, adaptive, usable, web-based courses for disabled learners and learners with the cognitive disability of dyslexia.

Keywords: Learner profile, Higher Education, Data and Information Management, Personalization, Disabled students, Dyslexic students

1. Introduction

According to the ACM/IEEE curricula (ACM/IEEE, 2001), "students need to be able to develop conceptual and physical models, determine methods appropriate for providing efficient solutions to a given problem, and be able to select and implement appropriate solutions that reflect suitable constraints, including scalability and usability". Revising the outcome expectations for Information Systems (IS) graduates and proposing subsequent changes to the curriculum topics, the IS 2010 model considers that Data and Information Management related courses are essential parts of Informatics education (Topi et al., 2010), (ACM/IEEE, 2013). Longenecker et al. based on current governmental and academic surveys of industry explored the IT labour market expectations, and suggested that "considerably more technical focus as well as depth of learning may well be required to meet the needs of the professional community befitting of the Computer Information Systems (CIS) designation" (Longenecker, 2013). According to CS2013 (ACM/IEEE, 2013), "The activity of developing or acquiring information technology applications for organizational and inter-organizational processes involves projects that define creative and productive use of information technology for transaction processing, data acquisition, communication, coordination, analysis, and decision support."

Data and Information Management (IM) plays a critical role in almost all areas where computers are used.

A major aim of a Data and Information Management curriculum is to enhance the collaboration between HE institutions, VET institutions, and ICT industry, by promoting the transfer of knowledge and skills between and across them. Equivalently, the aim is to facilitate the introduction of new topics and content to the HE and VET curricula; topics and content that reflect (a) the current trends in database technologies, and (b) the needs of the European labour market (Dervos et al., 2013), (Laiho, 2010), (Laux, 2012). It must also conforms to the international practice focusing on a practitioners' approach based on the principles of "Learning-by-doing", and "Learn by verifying in practice". It is expected that the "learning-by-doing" and experimenting with the live problematic situations raise the motivation of the learners (Dervos et al., 2013).

The following axes (perspectives) could be considered for the formation of a Course module on Data and Information Management:

1) Course contents, topics, and learning outcomes are related to the needs of the labour market

2) Training, recommendations and related educational material are conforming to the principle of "Learn by verifying in practice"

Combining efficient learner requirements elicitation with personalization techniques throughout the design and delivery of the instructional material is an extremely important aspect for providing adaptation to the needs and interests of individual learning groups (Skourlas et al., 2007)

Disabled learners and learners with the cognitive disability of dyslexia constitute learning groups which can be greatly benefited by such implementations.

Skourlas et al. (2007) consider that "National and institutional policies in Greece intensively foment the reformation of Higher Education (HE) in order to build upon the potential of new Information and Communication Technologies (ICT)". They also state that the integration of e-learning approaches constitutes an issue of high priority for tertiary educational institutions. They underline how important is to take into account the different learner profiles encountered in the higher educational context.

2. Personalization and user model

Jorg Diederich and Tereza Iofciu (2006) consider that User profiles can be used to identify persons inside a community with similar interests. They propose "to create user profiles from the data available in folksonomy systems by letting users specify the most relevant objects in the system". Two steps are described to create user profiles: 1) Define how the profile should look like

2) Define how to populate the profiles with actual data for particular users

Personalization could be simply defined as the process of making information systems adaptive to the needs and interests of individual users (Skourlas et al, 2007). Web personalization could be defined in the same way using the concept of the Web-based information systems (Yi and Hwang, 2003). Web personalization concerns data collection about the users, analysis of these data, and retrieval of the suitable data for the specific user at the suitable time (Pierrakos, 2003).

Personalization can be achieved with the use of a separate personalization server of multimedia educational material that makes use of various types of adaptive personalization: (a) personal user statistics, (b) stereotype modeling, and (c) community modeling. Each of the types requires the acquisition and maintenance of

a different user model, which is achieved with the use of statistical analysis and machine learning methods (Paliouras et al., 2006).

Three steps are important for successful personalization (Kobsa, 2001), (Paliouras et al., 2000), (Skourlas et al., 2007):

1) Collection of useful information about the users and their interests.

2) The collected data are processed to discover interesting patterns and, create user models. Individual learners are clustered and modeled according to their interests and abilities.

3) New educational material to be presented in the learner is chosen, together with the order of presentation using filtering (and ranking) techniques.

Instead of using the expensive Content-based filtering which is based on data preprocessing and analysis, the personalization server can use collaborative filtering to group the users into communities according to common characteristics and interests (Skourlas et al., 2007)

Individual user (learner) model may contain personal information about the users, as provided during the registration and information related to the description of sources and categories. Weight parameters can be defined based on the frequency at which the user chooses the particular source or category for new educational material (Paliouras et al., 2006).

Stereotypes are similar to personal user models, but they accumulate frequency statistics for all users with the same personal characteristics (Paliouras et al., 2006).

User communities are also aggregate models, but they are not predefined and do not contain personal information about the users. They are constructed with the use of machine learning algorithms. Example of such a machine learning algorithm is Cluster Mining (Paliouras et al., 2000), (Paliouras et al., 2006) which discovers patterns of common behavior by looking for all fully connected sub-graphs (cliques) of a graph that represents the user's characteristic attributes.

3. Dyslexic learners

Considerable work has been undertaken in the context of the World Wide Web Consortium's Web Accessibility Initiative (WAI) in order to make the use of the web easier for people with disabilities. WAI Design guidelines for disabled people and dyslexic people, and the other accessibility documents form a framework that includes guidelines regarding development and accessibility features of web sites, browsers and authoring tools, etc. There are translations of the documents into different national languages, and it is possible the visual appearance of pages to the needs of print-disabled readers. The possibility of speech synthesis for the text being read is also offered.

Skourlas et al., (2007) focused on people with disabilities and learning difficulties as learners and tried to understand and capture the individual learner's requirements. They mainly focused on identifying the "learner (dyslexic user) requirements".

There is no universal Dyslexia definition, and there are also definitions from a variety of references. One of the better definitions is offered by the British Dyslexia Association:

"Dyslexia is a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling. Characteristic features of dyslexia are difficulties in phonological awareness, verbal memory and verbal processing speed. Dyslexia occurs across the range of intellectual abilities. It is best thought of as a continuum, not a distinct category, and there are no clear cut-off points. Co-occurring difficulties may be seen in aspects of language, motor co-ordination, mental calculation, concentration and personal organisation, but these are not, by themselves, markers of dyslexia. A good indication of the severity and persistence of

dyslexic difficulties can be gained by examining how the individual responds or has responded to well founded intervention."

(In 2009 Sir Jim Rose's Report on "Identifying and Teaching Children and Young People with Dyslexia and Literacy Difficulties"
http://www.bdadyslexia.org.uk/dyslexic/definitions)

The British Dyslexia Association, the Centre for Educational Technology Interoperability Standards (CETIS) and other leading Associations propose principles and tips aiming at enhancing readability, accessibility, and customization of web pages for people with dyslexia. They present selected tips for fonts, colours, fonts' size, background, presentation style (e.g. characters per line, line spacing, margins, use of bold / italics, use of bullets), etc.

(http://www.bdadyslexia.org.uk/, http://jisc.cetis.ac.uk/,
http://www.american-dyslexia-association.com/)

Assistive technology can be used to provide the means to support individual users to work around reading, writing / spelling, and learning difficulties (Skourlas et al., 2007). Software in common use for supporting dyslexic people can be classified into the following categories:

1) Literacy Teaching integrated environments,
2) Text to Speech (TTS) software.

4. A framework for Learning based on User (Learner) profiles

Skourlas et al. (2007) consider that an adaptive, web-based system capable of providing personalized multimedia learning material in order to address particular learner subsets (stereotypes) and short-term individual preferences has been conditioned by the following principle [Agent-DYSL, 2006): "On the basis of the user profile and performance record, it is desirable that the system provides a range of features that will support its use within accommodative learning environments. This information would enable personalisation of the presentation of learning materials and course texts".

The system must support access, use, and handling of various types of educational material. Supported formats for text can include, at least, doc, and PDF documents. Multimedia content could be enhanced by multimedia features integration. The layout of the displayed documents should be simple and adjusted, and the content should appear using appropriate fonts, etc. Downloading and storage of documents for further work should be possible. Disable people and dyslexic learners should be supported by specific interfaces. Learners' profiles should integrate personalization and adaptive features.

Skourlas et al. (2007) consider that significant information about learners can include:

a) Age, first enrollment date / semester, class.
b) Prerequisite courses for specific courses. Examination marks for these courses offer additional information for learner's profile.
c) Previous training or professional experience.

Such information is useful for classifying the students into groups (e.g. "mainstream" class students, working students, students with special needs). It is also important to answer the following questions: What the learner is expected to learn? What s/he should be able to accomplish? How long it should take?

5. Review of methods for specifying/extracting Learners' profiles in Higher Education Informatics

A user profile can be thought of as being "a set of data representing the significant features of the user" (Germanakos et al., 2005). Germanakos et al. define user profiles, subsets of users who share common characteristics, based on: Demographic characteristics, Socio-economic characteristics, Psychographic characteristics, Individual physical and psychological characteristics (i.e. disabilities).

The collection of data about the users and their interests is performed explicitly, through form-filling, and implicitly, through the logging of usage data. Machine learning methods can be used to create adaptive user models that capture changes in the user's interests (Paliouras et al., 2000, 2006), (Pierrakos et al., 2003).

For each user, the system should maintain a 'user profile' which contains information about the performance of the user and user preferences.

Several methods form the initial learners' profile based on a pre-test that students have to take. The initial learners' profile could use: 1) Demographic information (e.g. gender) 2) previous experience and/or expertise in using ICT technology 3) Attitude towards learning, 4) Prior knowledge on study domain

Potential characteristics of the learners using ICT technology could include personal innovativeness, tendency to experiment, etc. (Schillewaert, Ahearne, Frambach, & Moenaert, 2005). Such characteristics could be measured by statements that are rated on a Likert scale.

A post-test could be used to update the (dynamic) learners' profiles.

We could include additional features of the learners, as for example, personality and individual characteristics (computer self-efficacy, openness to experience, etc.) which can influence in their acceptance and adoption of new technologies and devices (Devaraj, 2008). We could also include cultural differences of learners (Gabrielle & Helene, 2003).

Tzouveli et al. (2008) consider that web-based learning systems plays an important role for self-learning, however, learning systems do not generally adapt to learners' profiles. They introduce an e-learning schema that adapts to the learners' ICT (Information and Communication Technologies) knowledge level. Learner profiles are initially defined by the experts, and describe characteristics, needs, and preferences of learners. The answers to electronic questionnaires are used to select the profile of a new learner. Rothes et al. (2013) capture students' initial motives for enrollment by questionnaires that "were administered generally during the first week after the courses had started. At least one researcher was present during data collection. Students completed the surveys in approximately 15 min. Participation was voluntary, and anonymity was guaranteed." The following Instruments were used:

1) Questionnaire of motives for education and training. Ten motives are measured: epistemic, socio-affective, hedonic, economic, professional-operational, personal-operational, vocational, prescribed, derivative, and identity-based.
2) Learning Self-Regulation Questionnaire. It measures two factors: autonomous regulation, and controlled regulation.
3) Self-Descriptive Questionnaire-III. It measures multiple dimensions of self concept in college students
4) Academic self-efficacy scale. The academic self-efficacy scale of PALS (Patterns of Adaptive Learning Scales) is used.

To summarize, the following methods can be used for the assignment of the initial user profile (Paliouras et al., 2006):

- A profile can be manually built based on prior knowledge about the student.
- A profile can be automatically built based on an "assessment".

The profile will be updated when the learner uses the system.

As part of the personalization of the system to each individual user, several features can be tuned based on the profile of the user. The following features could be the subject of adaptation (Agent-DYSL, 2006):

1) Set-up of the system
2) Font type, size and colour
3) Speed of highlighting
4) Text analysis

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