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A recommender agent based on learning styles for better virtual collaborative learning experiences

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ABSTRACT

Almost unlimited access to educational information plethora came with a drawback: finding meaningful material is not a straightforward task anymore. Based on a survey related to how students find additional bibliographical resources for university courses, we concluded there is a strong need for recommended learning materials, for specialized online search and for personalized learning tools. As a result, we developed an educational collaborative filtering recommender agent, with an integrated learning style finder. The agent produces two types of recommendations: suggestions and shortcuts for learning materials and learning tools, helping the learner to better navigate through educational resources. Shortcuts are created taking into account only the user's profile, while suggestions are created using the choices made by the learners with similar learning styles. The learning style finder assigns to each user a profile model, taking into account an index of learning styles, as well as patterns discovered in the virtual behavior of the user. The current study presents the agent itself, as well as its integration to a virtual collaborative learning environment and its success and limitations, based on users' feedback.

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1. Introduction

Technology boost has enabled new education paradigms, such as: student-centered learning, situated cognition, communities of practice, distributed cognition, everyday cognition, and constructivism in general (Brown, 2005). Education does no longer mean only knowledge transfer, from teachers/tutors to students, but means community, working in groups, doing projects, sharing ideas with peers, being challenged, learning to support personal goals (Prensky, 2007; Zhang, de Pablos, & Xu, 2014; Zhang, de Pablos, & Zhang, 2012; Zhang, de Pablos, & Zhu, 2012). As a consequence of the emergence of the new learning paradigms and in order to cater the "neomillennial learning styles" of students (Liu, Cheok, Mei-Ling, & Theng, 2007), new forms of learning and education have appeared: the continuous education, the competences-oriented education, education at work, the online education, the collaborative education. Computer supported collaborative learning (CSCL) is among the most challenging new learning forms, as its value and its limits are still under research (Chikh & Berkani, 2010; Mukama, 2010; Othman, Othman, & Hussain, 2013). In CSCL, several students with different ways of thinking, feeling, and acting "work together to solve problems or build knowledge supported by specifically designed software" (Prinsen, Volman, & Terwel, 2007). CSCL is well-known for the fact that it provides educational opportunities for students with "low anxiety, high problem solving efficacy" and "time management problems in their learning strategies" (Solimeno, Mebane, Tomai, & Francescato, 2008), while loneliness and demotivations are among the main causes of failure in e-learning (Tobarra, Roblez-Gomez, Ros, Hernandez, & Caminero, 2014). Thus collaborative e-learning through virtual communities, wikis, forums, chat rooms, virtual worlds provided successful examples of virtual learning experiences (Zhang, Liu, de Pablos, & She, 2014; Zhang, Ma, Wu, de Pablos, & Wang, 2014; Zhang, Zhang, de Pablos, & Sun, 2014; Zhang et al., 2014). A growing body of research has demonstrated that personalization is essential in virtual collaborative learning experiences, if they aim to fulfill their full potential in nowadays education (Ashman, Brailsford, &

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Brusilovsky, 2009; Bodea, Dascalu, & Lytras, 2012; Dascalu, Bodea, Lytras, de Pablos, & Burlacu, 2014; Dragoi, Rosu, Pavaloiu, & Draghici, 2013; Hsu, Chen, Huang, & Huang, 2012; Mamat & Yusof, 2013; Stefan, Gheorghiu, Moldoveanu, & Moldoveanu, 2013). Starting from this premise, we propose in this study a personalization method of a virtual collaborative learning environment, represented by an e-learning community, through collaborative filtering recommendations.

The paper is structured as follows: after the introductory part (Section 1), Section 2 presents an extensive state of the art in the personalization of virtual learning environments domain, through educational recommendations and consideration of learner profiles in general and learning styles associated with those profiles in particular. Section 3 describes the proposed recommendation method. Section 4 presents the collaborative learning environment U-learn, in which the recommendation method was deployed. Section 5 reveals the preliminary results and discussions of our research. Conclusions are drawn in Section 6.

2. Personalizing virtual collaborative learning experiences

According to Ashman et al. (2009), personalization means identifying the most suitable information to the users' needs, taking into account a user model. In the particular case of e-learning, personalization could mean fostering a particular learning behavior so that the learners to achieve their goals. Personalized e-learning environments implement several challenging concepts: one-to-one/many-to-one learning and self-directed learning. While traditional e-learning environments implement the one-to-many learning concept (one tutor-multiple learners), personalized e-learning environments use one-to-one or many-to-one concept (one or several tutors for the same learner). In traditional e-learning environments, the learning units, their sequence, their content is established by the tutor, while in personalized e-learning environments they are chosen by the learner (self-directed learning) (Kurilovas, Kubilinskiene, & Dagiene, 2014).

Ashman et al. (2009) make an interesting debate upon the pros and cons of exploiting personalization technology in web-based learning: they notice that its use determines its value. Comparing with e-commerce personalization, e-learning personalization is still experimental, with less market penetration. Before exemplifying the benefits brought by personalization, one should take into account that it might be a threat to security and data privacy and not very reliable, as personalization algorithms might be prone to errors. Ashman et al. (2009) argue that people are complex and impossible to be sketched in a profile, which, in the end, is approximate. Offering personalized recommendations in a virtual environment can be detrimental to people, as in real life knowledge is not synthesized, but has to be discovered. Despite the cons of personalization, we think that learning should be a highly personal experience, thus personalizing virtual learning environments (VLE) would have great pedagogic benefits. Studies have demonstrated that learners participating in personalized learning environments are more motivated and more willing to spend time in the educational context than other students (Brusilovsky, Sosnovsky, & Yudelson, 2009; Weber & Brusilovsky, 2001). Last, but not least, personalization can be a support technology for people struggling with finding out the needed piece of information from the huge volume of Internet data which is, unfortunately, of variable quality.

2.1. Improving learning experiences through educational recommendations

Under the pressure of increasing the education effectiveness, most of the educational systems became learner-centered (Geven, 2010; Semple, 2000). A research on the adoption of learning-centered approach, made in several small colleges and universities (Weimer, 2002), indicates that the adoption of learner-centered paradigm is not initially welcomed by all students, some of them preferring a passive learning environment. But, in the end, almost all the students found the learner-centered experience as being superior to traditional ones, as a consequence of their ownership of the learning experience. Comparing the learner-centered with the traditional teacher-centered systems, Huba and Freed (2000) point out that the teacher' role changed from an information giver and primary evaluator to a coach, facilitator and contributor, providing relevant educational recommendations to students. Allan (2004) also considers that teacher should engage students in their learning, assisting students to master their learning objectives. Learning can mainly be achieved not based on delivery of information but on a real engagement of students, based on efficient indications/recommendations.

One of the most powerful vehicles for providing educational recommendations is the feedback provided by teachers to the students. Feedback, and especially formative feedback, is considered as being critical for improving knowledge and skill acquisition and increase the motivation for learning (Hattie & Timperley, 2007; Shute, 2007). According to Shute (2007), the formative feedback represents information communicated to the learner that is intended to modify the learner's thinking or behavior for the purpose of improving learning. The following six type of educational indications/recommendations are identified: attribute-related (information addressing central attributes of the target concept or skill being studied), topic-contingent (information relating to the target topic currently being studied), response-contingent (focusing on the learner's specific response; it may describe why the answer is wrong and why the correct answer is correct; this does not use formal error analysis), hints/cues/prompts (guiding the learner in the right direction, e.g., strategic hint on what to do next or a worked example or demonstration; it avoids explicitly presenting the correct answer), bugs/misconceptions (information requiring error analysis and diagnosis; this is information about the learner's specific errors or misconceptions, e.g., what is wrong and why), and tutoring recommendations (the most elaborated information, a combination of previous ones).

Hattie and Timperley (2007) introduce a model of feedback based on three major questions: "Where am I going?", "What progress is being made toward the goal?" and "Where to next?" (which correspond to feed-up, feed-back, and feed-forward educational recommendations) and four levels at which the feedback operates: the level of task performance, the level of process of understanding how to do a task, the regulatory or meta-cognitive process level, and/or the self or personal level (unrelated to the specifics of the task). Across these levels, the educational recommendations could have different effectiveness in reducing the gap between current and desired understandings.

Educational recommendations are not all the time effective, as they are not always accepted by the students – they can be modified or rejected instead. Educational recommendations can significantly improve learning processes and outcomes, only if they are properly designed and correctly delivered.

Research on technology-assisted education indicates that technology can support key practices of student-centered learning, such as assessing individual students' strengths and needs, flexible scheduling and effective educational recommendations (Moeller & Reitzes, 2011).

When debating upon educational recommendations mediated by technology, mentioning recommender systems is mandatory. A recommender agent gives the user suitable resources and guidance in a large space of possible options (Burke, 2002), thus increasing the visibility of proper e-learning resources (Zhang, de

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