Recommender System for Web 2.0 Supported eLearning

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***Abstract*— The paper presents the work-in-progress with the aim to develop recommender system for personalization of activities in e-learning 2.0 environment. The main components of the proposed system are activity, student and group models, and recommender module. Activity model will be used for learning design representation and will include items that could be recommended to students: e-tivities, possible collaborators, tools, and advices. To provide recommendations tailored to the student's and group's characteristics, an important component of the system will include student and group models. The emphasis of the research is on the procedures for assessing the student's (group's) activity level based on the data collected from the third party services (Web 2.0 tools). Student's model will also represent knowledge level and preferences. The recommender module will include original pedagogical rules together with the algorithms that adapt known recommendations techniques to the educational context.**

Keywords*— *recommender system; Web 2.0 tools; e-tivities; e-learning

I. INTRODUCTION

Research on *adaptive educational hypermedia systems* (AEHS) can be traced back to the early 1990's [1]. In an AEHS the goal of a student is to learn the material on a particular subject. Therefore, the user knowledge of the concepts being taught is one of the most important elements for adaptation. Besides the knowledge, there are some other aspects of the user (e.g. learning goals, skills, affinities, and learning styles) which can be used to adapt the navigation through courseware to a single student. Of greater importance in contemporary education is the implementation of collaborative learning strategies that introduce the necessity for an AEHS system to adapt to a group of students collaborating together [2].

Modern AEHS have been mostly used on a closed set of information items manually indexed by domain experts [1]. In order to apply adaptive hypermedia in open corpus (such as the Web) some other technologies should be used. Among the technologies that enable adaptation, *recommender systems* should also be considered in order to ensure efficient use of available web learning resources. Although the most of the current recommender systems have been designed for commercial purposes (entertainment, e-commerce) [3], those systems can be applied in technology enhanced learning (e-learning) as well [4].

New approaches in e-learning are associated with adoption of student-centred teaching model based on the constructivist theory of learning, and on using of Web 2.0 tools for collaboration, communication, (multimedia) content creation, sharing, tagging (e.g. Blogger, Flickr, YouTube, Wikispaces, Facebook) [5], [6]. To stress out the changes in learning processes induced by Web 2.0 and specially social software, a new approach to e-learning is called e-learning 2.0 [7]. The e-learning 2.0 approach is based on personal learning environments (PLE) in which a student owns personal space and organizes resources that have the potential to support his/her learning [8].

Despite the before mentioned changes in e-learning, it appears that the prevailing perspective in AEHS is still related to students' knowledge of subject matter. The students are provided with recommendations regarding sequences of subject matter presented within the course or additional learning resources [9]. According to the constructivist approach to learning, students should have the opportunity to construct their own version of knowledge through active participation in learning activities [10]. New e-learning activities (e-tivities) include discussions, concept or mental maps creation, blogging, problem-based assignments including creation of wiki documents or designing various multimedia content [11]. An e-tivity is achieved through completion of a series of tasks and oriented towards specific learning outcomes that should be achieved [12]. According to [10], the components that constitute such activity are: the context within the activity occurs (the subject, level of difficulty, the learning outcomes, and the environment within which the activity takes place); the pedagogy (learning and teaching approaches) adopted; and the tasks undertaken. The task specifies the type of task, the resources (e.g. teaching and learning materials, tools), the interaction and roles of the participants involved (e.g. work in pairs or teams).

All aforementioned components can be adapted to students' individual characteristics [9]. Of special importance are personalized recommendations or advices regarding the possible colleagues-collaborators, tools for realization of the e-tivity, or the e-tivity in general. Educational recommender system which will support generation of such advices should not take into account only interests and preferences of users [13], [14], but also knowledge level [15], [16], communication level [17], learning styles [15] and affective states [18].

To provide recommendations tailored to the student's characteristics, an important part of the recommender system is a student model. Besides afore mentioned characteristics, this

model could include the activity level which represents quantity and quality of student's contributions in e-tivity. If e-learning system implements collaborative learning strategies and adapts to a group of students, recommender system should contain a group model as well [19]. Group model can be created based on aggregation of individual student characteristics or by observing interactions of a group as a whole [2].

The paper presents research in the field of education recommender system for the context of e-tivities realized with Web 2.0 tools. It proposes the recommender system consisting of activity, student and group models, and modules for collecting/pre-processing data, student/group modelling and generating recommendations (Fig. 1). The article is organized as follows. Section 2 introduces main aspects of the proposed research. Section 3 outlines the structure of the recommender system by describing its components. Preliminary results, conclusions and future plans are presented in the last section.

II. PROPOSED RESEARCH

The aim of this research is to develop recommender system that will provide personalization in the context of collaborative e-tivities realized using Web 2.0 tools [6]. The important part of the research are novel procedures for assessing student's (group's) activity level. Activity level represent quantity and continuity of student's contributions relatively in respect to others students (group or class members), as well as group's contributions relatively in respect to other groups. Data regarding activity level is, besides other characteristics from student/group model, used in recommendation rules in order to rank possible collegues - collaborators, Web 2.0 tools or optional e-tivities, as well as to generate advices regarding participation in e-tivities.

The main objective of the research is to verify that personalized recommnedations increase student's performance in e-tivities.

III. RECOMMNEDER SYSTEM COMPONENTS

The main components of the recommender system represent items that will be recommended, target students and groups, and rules for generating recommendations. Those are: activity model, student and group models, and recommender module (Fig. 1).

A. Activity model

Activity model is used to describe learning design of a course realized in pure or blended model of e-learning [20], [21]. Learning design represents two level activity workflow in a form of directed graphs. First level represents modules included in the learning design while second level represents workflow of activities grouped to particular module. Planned activities are classified into several categories (*f2f* activity, content learning activity, testing activity, e-tivity, decision activity, support activity), depending on their purpose and part of the e-learning environment in which they are performed (Fig. 2). E-learning in chosen environment that consist of LMS and third party services (2.0 tools available on the web) assumes that students use the LMS to read prepared learning material, take online tests, etc. , up to the point when they need

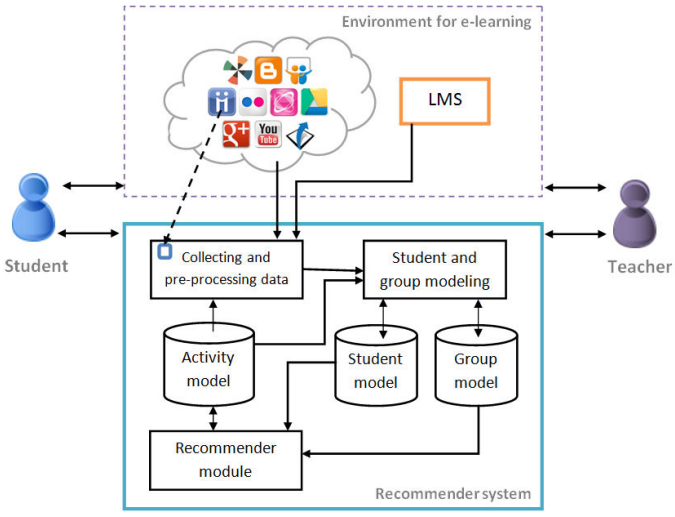

Fig. 1. System structure

to perform e-tivity using Web 2.0 tool (e.g. write a learning diary using Blogger). When students need to complete a task divided in groups or pairs, teacher defines the e-tivity as group-based.

Recommender system will be used in parallel with LMS and Web 2.0 tools for different support activities which are not directly intended to learning outcomes. Such activities enable delivering additional instructions, links to created/published content and similar. The system will also enable presentation of recommendations (e.g. collaborators for group-based e-tivity) within decision activities. In order to recommend possible collaborators, the model contains information about which students participate in which activity. Personalization in the form of recommendations for additional (optional) e-tivities will be achieved by defining a group of e-tivies among which students will choose one. To provide personalization in terms of tools used to accomplish task, teacher can offer (if possible) more than one tool. The students will choose the one of those tools that suits their preferences the best. Therefore, activity model also consist predefined extendable set of ten Web 2.0 tools:

- Blogger, for publishing blogs,
- Diigo, for collecting and organizing bookmarks and other resources,
- Flickr, for photo management and sharing,
- Gliffy, for online diagram and flowchart drawing,
- Google+, for social networking, sharing and communication,
- Google Documents, for creating and sharing documents,
- MindMeister, for online mind mapping and brainstorming,
- SlideShare, for sharing presentations,
- Wikispaces, for creating wikis,
- YouTube, for editing and sharing videos.

The part of the activity model also includes predefined set of advices that will be presented to students during and at the end of e-tivity.

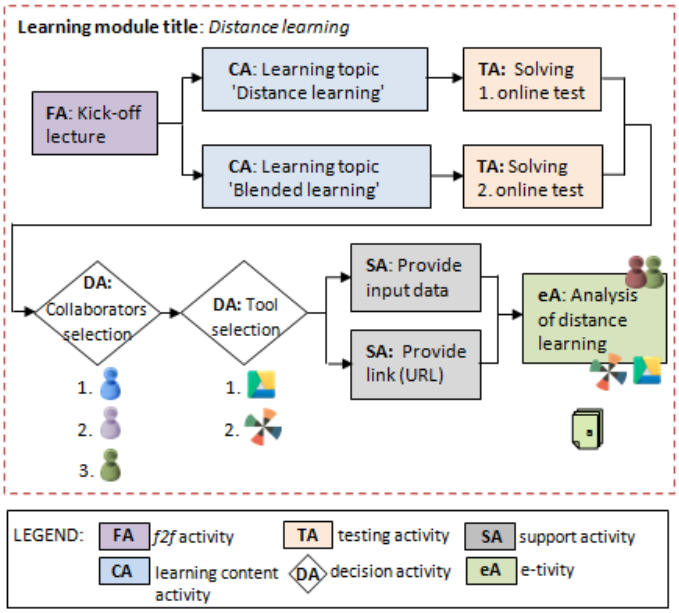

Fig. 2. An example of learning module design

B. *Student and group models*

The most important part of the system is the one containing components used to represent student's and group's activity level. Activity level assessment is performed using certainty factors theory [22] in three main phases: data collection, data pre-processing, and student/group modelling.

First two phases are performed within the module for data collecting and pre-processing. In the first phase, data regarding student's actions is collected from third party services (Web 2.0 tools) used for e-tivity realization. Data retrieval is performed via API or RSS, using adapters implemented for each service from predefined set. Described procedure includes degree of uncertainty that should be taken into account (data is unavailable, incomplete, inaccurately represented or similar) [23]. Data collected in XML or JSON format is then parsed, interpreted and classified in order to determine quantity of contributions and their distribution by intervals defined by teacher.

Based on quantitative analysis performed in second phase, student's activity level is estimated relatively to others participants (class or group members) in the third phase. In case of group-based activity, group activity level is estimated as well, relatively to the other groups. These procedures are based on experts rules and certainty factors theory and performed in the module for student/group modelling. Calculated data is stored in corresponding models. It will be presented to students to provide insight into engagement of other students (collaborators) and other groups, as well as generation of recommendations (as main purpose).

Obtained values will be also presented to teachers that can use them when evaluating or grading the level of student's contribution in collaborative e-tivity: a teacher will decide upon number of points that will be given to each group member according to the criteria that includes not only a quality but also a quantity of contributions.

Student model will also include information about the knowledge level of course content. It is assumed that this information will be determined on the basis of online assessment within the used LMS and collected automatically or entered by the teacher.

In addition, recommendation algorithms will take into account student's preferences regarding Web 2.0 tools and learning styles according to VARK model [24]. This information will be collected in a form of questionnaires and stored in the student model. Group model will contain only information about the activity level. Other afore mentioned characteristics will be taken into account in the recommendation process, but based on aggregated data for group members from student model. To represent student's and group's characteristics overlay model [1] with numeric values will be used.

C. *Recommender module*

Recommender module includes rules and algorithms for generating four different types of recommendations on the basis of data from activity, student, and group models. Appropriate techniques for certain type of recommendations are selected according to the purpose of the system, and taking into account the potential problems that might occur due to the small number of users or items. Thus, the used techniques include recommendations based on knowledge in order to enable the application of teacher's (expert's) knowledge on usefulness of certain items (collaborators, e-tivities, advices) for individual students [4].

For additional support to personalization, used techniques include collaborative filtering and content based recommendations [3]. Collaborative filtering was adjusted to the educational context by introducing pedagogical criteria to the process of determining the similarity among users.

IV. Preliminary Results, Conclusions and Future Plans

This work contributes to research on recommender system for personalization of activities realized with Web 2.0 tools so it proposes recommender system that consists of activity, student, and group models, and recommender module.

The prototype of the system is currently in the final stage of development. It will be evaluated using subjective and objective methods. For that purpose, the learning design of the course 'Hypermedia in education' was created. The course workflow includes individual and group-based e-tivities that will be realized using Web 2.0 tools. One of the modules is presented on Fig. 2. Participants will be students of the Department of Informatics at the University of Rijeka, Croatia.

Before the final evaluation that will be conducted in order to determine the impact of the recommender system on student's performance during e-tivities, several components were already tested. Web 2.0 tools were previously used within e-learning courses. They found to be reliable, and that their performance match the expectations and needs in practice. Adapters implemented for those tools were also tested. To assure collection of accurate activity data, the adapters were improved according to identified prerequisites.

Validation of the algorithms for assessing student's (group's) activity level will also precede final evaluation of the system. It aims to determine to what extent obtained values match the actual state.

The system is developed for the educational context and, besides preferences, takes into account student's needs and characteristics. According to that, the evaluation will include validation of the recommender system from pedagogical aspect, which is in line with the main objective of the research. The comparison of points per e-tivities included in the course leaning design will be made for students from control and experimental group. In addition, subjective methods (surveys, interviews) will examine the students' satisfaction with the recommendations, immediately after the presentation, and at the end of the course.

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