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Competency Management for Group Formation on the AulaNet Learning Environment

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Abstract. The IMS Project uses the notion of competency to model educational objectives. In the AulaNet learning environment competency management is used to form subgroups that, in the case of this article, are assigned to generate new educational content for the Information Technologies Applied to Education course. The purpose of this course is to get learners to learn to work with information technology as a group, turning them into Web-based educators.

1. Introduction

Compared to people working only by themselves, working in groups has advantages such as synergy, the ability to consider more information, objective evaluation, cognitive stimulation and member learning from other members [1], which can be very useful both in work and learning environments. However, it is not an easy task to form groups envisaging collaboration. Management of competencies allows the coordinator to apply some criteria to the group formation process, in order to try to achieve the desired results of the collaborative activities.

This document shows how competency management was applied to extend the AulaNet[1] learning environment in order to provide features that could aid the group formation task. It also discusses the use of these new functionalities in the ITAE (Information Technologies Applied to Education) course, a discipline held entirely on the AulaNet environment for undergraduate and graduate Computer Science students as a field experiment for such new technologies.

The following section briefly describes the AulaNet by summarizing the 3C Collaboration Model that guided its development and its services. Section 3 presents some aspects of the ITAE course, aimed to promote change in the learner's working methods. Section 4 details the competency management features implemented to aid group formation and their use in ITAE. Finally, section 5 concludes the paper.

[1] http://guiaaulanet.eduweb.com.br, http://www.les.inf.puc-rio.br/aulanet

2. The 3C Collaboration Model and the AulaNet

To collaborate, people should debate ideas (communication), organize themselves (coordination) and operate together in a shared workspace (cooperate). Communication leads to commitment in performing tasks in order to have some job done. Coordinating these tasks is important to guarantee they are accomplished in the correct order, at the correct time and according to the restrictions imposed. The tasks are accomplished by the cooperation among the members of the group, which operate together in a shared space. This model is presented in Figure 1.

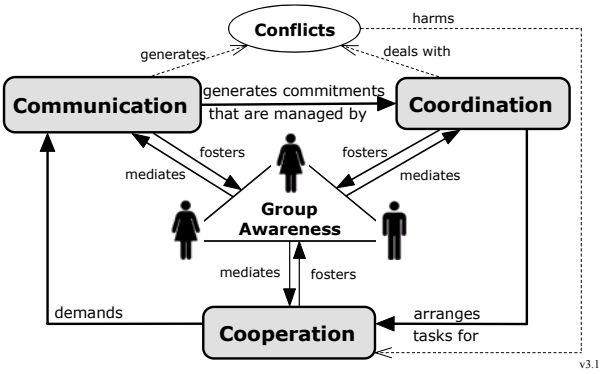

FIGURE 1. THE COLLABORATION MODEL

The AulaNet and the ITAE were developed with this model in mind. On the AulaNet, all the services are organized into communication, coordination and cooperation services. The AulaNet services are placed at the disposal of coordinators during the creation and updating of a course, allowing them to select those that they want to make available to the learners. In the ITAE, the course's coordinator adds services to the course as it unfolds in order to smooth the absorption of the environment by the learners.

The communication services provide facilities to allow the exchange of information. These services include: individual electronic mail exchange with the mediator (Contact with the Teachers); electronic mail with the entire group (Discussion List); asynchronous text discussion in a forum style (Conference); synchronous text chat (Debate); and the instantaneous exchange of messages with participants who are connected to the course (Messages for Participants). Since ITAE is a course that is mainly based on participant interaction, it uses all of the communications services.

The coordination services, which are designed to organize the group, in AulaNet include a notification tool (*Notices*), a tool for the basic coordination of the flow of the course work (*Lesson Plan*), assessment tools (*Tasks* and *Exams*), and a tool for monitoring group participation (*Follow-Up Reports*). The ITAE course uses the following coordination services: *Lesson Plan*, *Tasks* and *Follow-Up Reports*.

The cooperation services provide the means for cooperative learning [7], problem resolution and course co-authorship, both for teachers (*Teacher Co-Authorship*) and for learners (*Learner Co-Authorship*). The cooperative services also include a list of extra contents that are not associated with any specific lesson (*Documentation*), and references to textbooks (*Bibliography*) and Internet pages (*Webliography*). The ITAE uses *Bibliography*, *Webliography*, *Documentation* and *Learner Co-Authorship* cooperation services. The *Learner Co-Authorship* service is used by learners to supply new content to the course, which is validated by the course coordinator.

3. Some Aspects of the ITAE Course

The objective of the course is to make educators use the new technologies for teaching/learning. The course was taught for the first time during the first half of 1998 and, since then, one edition has been held each semester. In the beginning, the course structure included a weekly, live face-to-face class that was transmitted to outside learners, and a debate via the Internet, using the Debate service. This embryonic version of the ITAE served to generate educational content for the course, which was generated by recording the teachers' presentations during the weekly classes and by copying the transcripts of the chat sessions. As it was generated, the content was made available within the environment and learners could access it at any time and from any computer connected to the Internet.

Evaluation of learners in the ITAE is based on their participation and the quality of their contributions [13]. Although the AulaNet contains an evaluation service in the form of exams with questions, the ITAE did not make use of this service in order to evaluate learners based on collaborative rather than individual tasks. To help the mediators accompany the learners and to make it possible for the learners to evaluate their own level and quality of participation, follow-up reports of the environment were used to present information about the quantity, quality and type of participation [3]. To supply qualitative information, every and each participation has to be evaluated by the mediators, who need to grade and comment individual participation in the *Debate* and the messages in the *Conferences*. The *Discussion List* messages are not evaluated, since they are not part of the learners' tasks.

In the ITAE, most of the communication and all content self-study are conducted asynchronously. In asynchronous events, learners can participate at a time and place convenient to them and appropriate to the task, having more time to reflect before composing their messages [5]. In addition, though extrovert personalities continue to send more messages than quieter members do, they cannot dominate completely as in face-to-face or synchronous situations. Quieter members still have the opportunity to contribute, as described by [12]. But by reducing the pressure to respond, since it can be done at any time, it is easier for a learner to drop out of the group [6]. The mediators have to demand regular contributions in an appropriate timeframe to avoid dispersion. The Follow-Up reports helped to identify who was and who was not participating.

The last phase of the ITAE course is to have the learners actively generating content for the course's repository. To that end, the class was divided into subgroups,

based on the learners' competencies. For that purpose, the IMS Global Learning Consortium Reusable Competency Definition [10] was implemented in AulaNet.

4. Using Competency Management to Form Groups for Collaborative Content Generation

The Instructional Management Systems Global Consortium (IMS) is a well-known organization in the learning technology field, devoted to the establishment of standards and specifications. To model users' profiles and learning groups, AulaNet follows two IMS specifications: the Reusable Definition of Competency or Educational Objective [10] and the IMS Enterprise Specification [9]. In such specifications, the word *competency* is used in a very general sense that includes skills, knowledge, tasks and learning outcomes.

4.1. Modeling and linking competencies to content and participants

A RDCEO is basically comprised of a globally unique identifier and a human readable title and description. Many other optional fields make the model flexible to be extended according to the specific needs of the application.

On the AulaNet environment, they are linked to the contents (lectures, tasks etc.) of a course and, consequently, to the course itself. For the users, they are called Topics. As a result, the RDCEOs on any given AulaNet server reflect the competencies the courses being taught on that server deal with (either as prerequisites or learning outcomes).

AulaNet also links RDCEOs to people, in an association named Competency, explained in the next section.

4.1.1. Interest, Qualification and Performance

In the context of AulaNet, a learner's competency is expressed by three different factors (or dimensions): qualification, interest and performance.

Interest reveals how much a learner is willing to be in contact with tasks or lessons involving that competency. It is used, for example, to form learning groups in the scope of a class, dividing up the learners according to the topics each student finds more appealing.

Qualification is a declaration made by a learner stating his/her level of mastery (from novice to expert) regarding the competency represented by a RDCEO. It may or may not be backed up by a document such as a diploma or certificate. It maps what the student has learnt from outside the AulaNet environment. For example: in the context of sales force training, it could reflect how many sales a student has accomplished in practice.

Performance is very similar to qualification, except that it is automatically filled out by the AulaNet system, according to the learning outcomes. It can be seen as a transcript of the learner's academic life on the AulaNet. The environment sets the

level of mastery of a performance item after processing the grades a learner got on course activities, according to the following:

- The weight of the type of activity. For example: Tasks are more relevant than Debates.
- The weight of the RDCEOs they encompass. Although an activity is usually an indivisible unit, it may regard to more than one RDCEO. Example: a certain activity refers to 2 RDCEOs; one being relevant to 75% of the activity, whereas the other is referred in the remaining 25%.
- The obsolescence of the assessment. It reflects the tendency that newer grades are more accurate than older ones, as a person's competency changes over time.

Worth of mention is the fact that interest and qualification/performance are allowed to vary independently. Meaning that it is entirely possible to, for example, be very interested in a specific RDCEO but be a novice on it. Or, to be interested exactly because it is one's expertise.

This three-dimensional structure of an AulaNet RDCEO also reflects the different ways a learner can be evaluated in regard to a competency. Self motivation is reflected by the interest parameter. Self evaluation is reflected on the qualification parameter, which shows the learner's own point of view about how qualified he/she is regarding that specific topic. And, when a docent assigns grades and weights to the collaborative activities learners performed during a course, it influences the learners' performance parameter. As the grade may be the product of a group work, letting the group members divide among themselves the points earned by the group as a whole gives learners the chance to be evaluated by their own peers.

4.1.2. Issues concerning the use of RDCEOs

On previous editions of the ITAE course, learners reported difficulties in evaluating themselves. Apart from being a cultural issue (participants were not used to self evaluation, feeling uncomfortable with it), it is believed one of the reasons for that was the lack of a thoroughly detailed explanation of the mastery levels of the RDCEOs used. To remedy that, the RDCEO's optional field 'Definition' is going to be used to describe proficiency levels in more detail.

Another issue Kay [11] points out is the overhead imposed to the learner in managing his RDCEOs declarations, a task that could become a distraction or be completely neglected. With that in mind, ITAE learners are encouraged to manage their RDCEOs at the breaks of the academic schedule. To enforce this policy, ITAE requires the fulfillment of the qualifications and interests of its RDCEOs as part of the enrollment process. Furthermore, notice that the responsibility for the RDCEOs is split up with the different roles there exist in the system: The system administrator defines the RDCEOs; Course Coordinators include RDCEOs into their courses (as Topics); Course Mediators (lecturers) link these topics to the course content; Learners, with the help of their Mentors (a supervisor, e.g.: the head of the employee's department or a professor guiding a graduate student), fill up their interest and qualification profiles; and the AulaNet calculates the performance coefficient.

4.2. Subgroups in AulaNet and the matchmaking algorithm

At AulaNet, there are three different levels of granularity of a group. The first and broader one is 'course'. Enclosed in a coursed are its 'classes' (groups). Learners and mediators belong to a class. The course coordinator belongs to the course, overseeing all of its classes. Optionally, a mediator can further subdivide learners into 'subgroups'.

Subgroups are modeled in the AulaNet environment according to the IMS Enterprise specification, which recognizes the existence of the three core data objects described on the following conceptual model retrieved from [9]:

1. Person: the individuals who are undertaking some form of study and/or group related activity (…)
2. Group: a collection of objects related to learning activities or individuals. (…) There is no restriction on how the Group and sub-group structures can be used with respect to containing other groups, persons, etc.
3. Group Membership: (…) is used to define the members of a Group. A member can be a Person or another Group (…)

Presently, subgroups are used in association with the *Tasks* service. When a subgroup is created, it is not immediately associated with a task. That allows the mediator to create several different subgroups, not restricting the number of members on each subgroup or the placement of a learner in more than one subgroup. This way, the mediator is given the freedom to form subgroups at any point of the course and to group learners differently, according to each activity.

Once created, a subgroup remains inactive until the mediator associates it with a task. A subgroup can be associated with more than one task, in a structure flexible enough to allow a mediator to assign a learner working in two or more tasks to perform each task with the same group of people, with different people or even to work alone in any of the tasks.

Mediators can resort to the environment's automated subgroup formation feature when subdividing a class. The matchmaking algorithm [2] is designed to better relate learner's competencies to the tasks to be accomplished. It takes the following input provided by the mediator: the number of subgroups to be formed; the number of members in each subgroup; whether a learner can be assigned to more than one of the subgroups to be formed; what RDCEOs are to be taken into account; what dimensions will be analyzed; and the degree of difference (regarding qualification/interest/performance) among the learners. The mediator is free to accept or rearrange the subgroups automatically formed.

For example: mediators may be interested in forming subgroups either by homogeneity or by heterogeneity. By selecting an RDCEO and setting a degree of zero in respect to *interest* and four to *qualification/performance*, the mediator is promoting the formation of subgroups whose members are all interested in the same topics, but differ significantly in their qualification and performance. This could be used, for example, when the mediator wants to put together experts and novices with the same interests regarding a specific topic.

4.3. Collaborative generation and evaluation of educational content

In ITAE, in the end of the course, subgroups of two or three learners are formed using the matchmaking algorithm, using as RDCEOs the topics in the syllabus of the ITAE course. The aim is to group learners according to the topics they would like to study the most, putting together learners with somewhat similar competencies.

The subgroup organizes itself in order to generate interactive multimedia educational content and must submit it by a given date. Then, a period of collaborative peer review begins during which the members of at least three other subgroups evaluate each subgroup's content. This evaluation takes place in conferences created specifically for this purpose. Within these conferences, learners discuss problems regarding the content that has been generated. Once this period is over, the subgroups are given a new deadline to present a revised version that incorporates the contributions of their colleagues. The course mediators evaluate this revised content, and some may be invited to become a part of the course's repository.

5. Conclusion

The contribution of different understanding or the exposure to alternative points of view can enhance learning [8]. Group members can monitor individual thinking and the group structure provides social support and encouragement for individual effort [1]. In addition, through formulating ideas in their words, and receiving evaluation from peers, learners' knowledge, thinking skills and meanings are socially constructed [7].

As Web-based educators to be, learners are supposed to be able to generate interactive multimedia didactic content that will be added to the course's repository. Different from their own educators, Web-based educators work in a collaborative way to generate such contents. For that purpose, they are subdivided into subgroups based on their competencies.

Extending IMS RDCEO's Competency Model with the dimensions Interest, Qualification and Performance it becomes possible to run a matchmaking algorithm to define groups that best correspond to a set of criteria established by the course mediator. It is being used to divide up a class into the topics of the course, one group for each topic.

Other possible future uses involving competency management could be: defining a learning or career plan, determining pre-requisites to activities and selecting the appropriated content to be offered to a learner.

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