Prescribing e-Learning Activities Using Workflow Technologies

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Abstract. In this paper we propose a new coordination approach for the AulaNet Learning Management System. The proposed coordination protocol is based on a workflow mechanism that could be used by teachers to define some specific sequence of activities within a course run within AulaNet. This way, at least part of the social protocol that governs the flow of the course could be enforced by software.

1 Introduction

The necessity of coordination mechanisms to regulate interactions in groupware systems has been the center of a heated discussion. At one side, there are normative models that try to regulate the collaboration by restricting the interaction between participants and their tasks. The criticisms on such normative approaches may be roughly summarized by the fact that their rigidly defined protocols applies only to very specific scenarios, limiting the flexibility of the collaborative systems. Eventually, there would be situations not predicted by the specified protocols, restraining the application of this kind of coordination approach.

At the opposite side, are those advocating that collaborative systems should take flexibility to the extreme, leaving the coordination burden to the users. The criticism on this kind of approach is that they augment the coordination workload, since users must deal with the complexity of articulating their tasks. Moreover, giving the coordination responsibilities for the users does not guarantee that the activities will be performed according to any prescription.

The discussion makes sense because there are different kinds of collaborative activities. There is a large group of activities (tightly integrated collaborative activities) whose tasks depend on one another to start, to be performed, and to end. They require sophisticated coordination mechanisms in order to be supported by computer systems. A coordination mechanism is defined as “a specialized software device, which interacts with a specific software application so as to support articulation work” [11].

On the other hand, coordination does not need to appear explicitly in some kinds of computer-supported collaborative activities—loosely integrated collaborative ac-

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tivities [9]—such as those realized by means of chats or audio and videoconferences. These activities are associated with social relations and generally are satisfactorily coordinated by the standing social protocol, characterized by the absence of any computer-supported coordination mechanism among the activities, trusting users' abilities to mediate interactions. The coordination, in these situations, is culturally established and strongly dependent on mutual awareness (to be aware, in this context, is to acquire information about what is happening and what other people are doing [3]). The coordination workload and the limited flexibility imposed by rigid coordination approaches are completely awkward for loosely integrated collaborative activities, which are more suited for the awareness-based approach.

In spite of this discussion, there is a trend to conciliate both ideas, arguing that both kinds of activities are "seamlessly meshed and blended in the course of real world" [12]. This is especially true in e-learning, which is the focus of the paper. At one side, there is the necessity to "create software supports that enable learners to follow a range of paths to completing projects" [4]. At the other side, there is the necessity to have a flexible environment where learners are able to determine their own paths, according to their knowledge background, time constraints, or access limitations.

In this context, this paper presents the experience of using AulaNet, a Learning Management System, to run a course called ITAE (Information Technology Applied to Education). The course has a well-defined dynamics, and the coordination is currently based completely on the social protocol. Having this experience as background, the goal of this work is to explore the possibilities of using workflow technologies within AulaNet not only to coordinate the course's dynamics, but also other aspects of learning activities, trying to conciliate the flexibility of the social protocol with the normative regulation offered by workflows.

2 AulaNet and its Use in a Distance Course

In this section we present the AulaNet environment and the dynamics of a course that uses it. The course dynamics suggests the use of workflows (section 3) to coordinate the activities that the learners must realize through AulaNet services (section 4).

2.1 The AulaNet Environment

AulaNet is being developed since June 1997 at the Software Engineering Laboratory at the Catholic University of Rio [7]. It is freeware, and is available for download in Portuguese, English, and Spanish versions (http://www.eduweb.com.br). In order to access the different services available at the course, the learner uses a menu represented by remote control unity (Fig. 1).

The AulaNet is based on a groupware approach. To work in group, people need to exchange information (i.e., to communicate), to organize themselves (to coordinate) and to act together in a shared space (to cooperate). Awareness, which is the act of acquiring information through the senses, also plays a central role in this model.

These three concepts—communication, coordination and cooperation—are the main elements of the 3C model for collaborative work (Fig. 2a) [7]. Based on this model, groupware applications are classified according to their support to each of these concepts, being located in a triangular space presented in Fig. 2b [2].

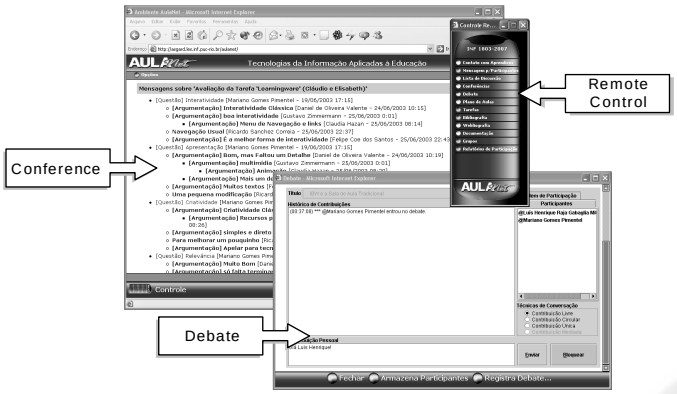

Fig. 1. Services accessed by the remote control

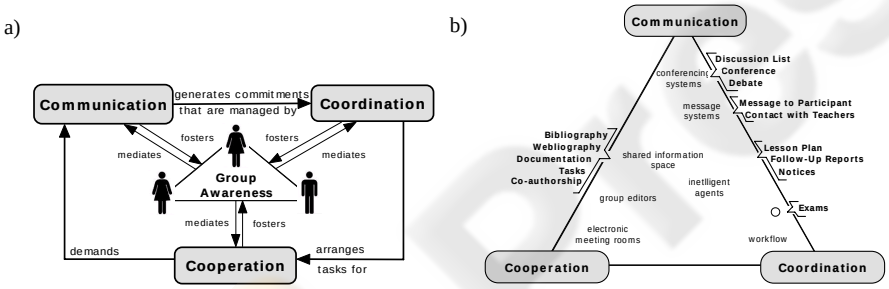

Fig. 2. a) The 3C Collaboration Model; b) Classifying applications according to the 3C model

The communication services of AulaNet allow the message exchange among the participants of a class. The *Discussion List* and the *Conference* services enable the asynchronous message exchange among participants. The *Contact with Teacher*s service offers private and asynchronous communication between a learner and the teachers. The *Debate* service is a chat tool for synchronous communication among all the participants. The *Message to Participants* service is an instant messenger that establishes the synchronous message exchange between two participants.

The coordination services of AulaNet were designed for teachers. The *Lesson Plan* enables the teacher to organize the course contents. The *Exam* enables the creation of multiple-choice questions for an evaluation of the learners. The *Follow-up Reports* service presents information about learners' participation within the course activities.

The cooperation services define different spaces for information exchange. The *Bibliography* and *Webliography* services offer the teacher the possibility to create references for documents. In the *Documentation* service, didactic content can be

disposed dissociated from the *Lesson Plan*. Finally, the *Task* service defines an activity in which learners must generate content that will be available to the other learners.

The creation of a course with AulaNet consists in the selection and configuration of the services that are going to be used during the course, which may be done in advance or on the fly, during the course.

2.2 Dynamics of a Course using AulaNet

The ITAE course has been taught since 1998 as a regular course of the Computer Science Department at PUC-Rio and is entirely taught via the Internet within the AulaNet environment. The main objective of the course is to train educators to use the new information technologies for teaching and learning in a collaborative way [6].

The ITAE is organized as a set of collaborative activities. Table 1 presents the program for the first semester of 2003. This table defines the activities, their dates and the AulaNet services used in these activities.

Table 1. Program of ITAE for the first semester, 2003

Phase	Activity	AulaNet Services
Introduction	13/03 (12AM) – Inaugural session 13/03-24/03 – Learners self introduction	None (classroom) Discussion List
Study and discussion of the course's topics	14/03-20/03 – Introduction to AulaNet and ITAE 21/03-27/03 – Groupware and Digital Communication 28/03-03/04 – Web based Instruction (WBI) and Classroom 04/04-10/04 – Learningware 11/04-24/04 – Facilitating WBI and Learning Concepts 25/04-08/05 – Teaching, Learning and Implementing WBI 09/05-15/05 – Interactive Multimedia and WBI Design 16/05-22/05 – New Trends in WBI	Conference and Debate
Content generation and publication	23/05-16/06 – Content generation about a specific topic 17/06-23/06 – Collaborative evaluation of the contents 07/07 – Publication of the revised contents	Task Conference Task
Closing	14/07 – Final degrees publication	Discussion List

The Introduction comprises a face-to-face session in the classroom (the only one) where the course's dynamics and guidelines are presented. Then, learners introduce themselves to each other using the *Discussion List* service. This first message is used to tell their expectations, how they learn about the course, etc.

The ITAE course is organized by topics. Every week during the Study and Discussion phase, the learners should study all contents regarding the weekly topic. From 12AM Monday to 2PM Wednesday all learners have to send their messages to the conference seminar where that week's topic is being discussed. On Thursdays from 12AM to 1PM all learners join the weekly debate to round up that week's topic study.

After the Study and Discussion phase, learners are subdivided into small groups to generate content based on a specific topic determined by the mediators. The content prototype is submitted to the other group's appreciation using the *Task* service. The course closes with the publication of the final degrees in the *Discussion List*. This

degree is calculated based on the quality and quantity of the messages sent by the participant to the conferences and to the debates, together with the general appreciation of the content generated by its group.

Currently AulaNet has no workflow mechanism to manage the phases of the courses. In the ITAE case, a Learners' Companion Guide is made available at the beginning of each semester defining dates and activities. The coordination of these activities is done by mediators, enforcing the social protocol sending messages to the *Discussion List* and Message *to Participants* services. Therefore, AulaNet lacks a workflow service to formalize at least partly of what is defined in the Guide.

3 Workflow Technologies

The Workflow Management Coalition defines workflow as "a process definition that consists of a network of activities and their relationships, criteria to indicate the start and termination of a process, and information about the individual activities, such as participants, associated IT applications and data, etc." [13]. Basically, a workflow defines procedures composed of a sequence of activities, establishing their relations, the resources needed for the execution of each activity, and criteria for activities termination. Moreover, a workflow may also define roles or groups that indicate who is responsible for the execution of each activity. Two important contributions of workflow technologies are the separation of the business process logic from the implementation of activities and the connection of independent activities, allowing the migration "from islands of automation to system support for the overall business process" [8].

"Conventional" workflow systems fit in the normative coordination approaches, being more adequate to tightly integrated collaborative activities. However, it is recognized that, in order to be useful for the majority of real world procedures, they should be flexible [5].

In order to refine the interdependency relations among activities and to enhance the flexibility of the workflow representation, we use some dependency operators [9]: *enables*, *forces*, *blocks* and *unblocks*. The *enables* operator represents what is called a passive interpretation of the relation. In this case, "activity A *enables* activity B" means that activity A is a prerequisite to the execution of B, but the execution of A does not imply the execution of B. This operator is more relaxed than *forces*, which represents the opposite situation. If "activity A *forces* activity B", then activity B must be realized after activity A. The *blocks* operator indicates that the execution of an activity blocks further executions of another activity.

In the following section it is shown how the workflow approach is used to model ITAE dynamics, serving as a means to implement a computational support for the course coordination. Especial attention will be given to the trade off between the rigidity of a workflow and the flexibility of the current social protocol. Moreover, some other possibilities of using workflow technologies within AulaNet are also explored.

4 Coordinating Activities in AulaNet

In section 2.1 it was shown that AulaNet offers coordination services. Although these services are related to coordination, they actually stand for awareness instruments for teachers and learners, which will use the information provided by these services to guide their activities. For example, the *Lesson Plan* is used to organize the course contents and offers the learners an indication of the order in which the contents should be navigated. However, this does not guarantee that the learner will follow the course sequencing, or even that any content will be opened. Therefore, one may conclude that the current coordination services of AulaNet are instruments to support the social protocol, which is actually the coordination means currently available within AulaNet.

Nevertheless, a workflow service may be used within AulaNet to coordinate some of the educational activities. The first step in any workflow implementation is to model the process that needs to be coordinated. For the AulaNet context, the ITAE course is a good starting point, because the course process is well defined and documented in the Learners' Companion Guide, as presented in section 2.2.

Fig. 3 shows the workflow of the ITAE course from a learner point-of-view. It starts with the course and members introduction. Then, there are 8 content studies, each of them composed of content readings, seminar and synchronous debate. Finally, there are the content production, which is also subdivided into three sub-activities, and the course finalization, with the degree assignment.

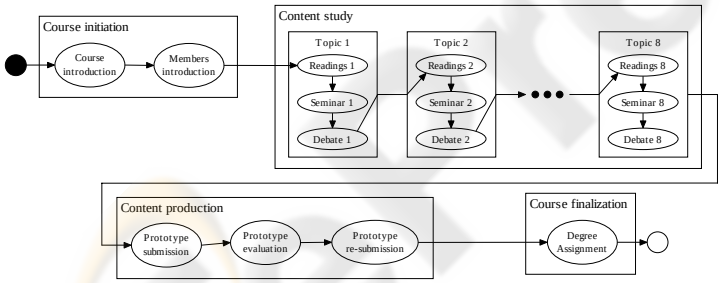

Fig. 3. Workflow of ITAE activities: Overall view

The overall view of the course workflow indicates that it is necessary to have a hierarchical representation of activities. In Fig. 3, for example, the composed activities represented inside the boxes are internally subdivided into more detailed sub-activities. For example, the content production by the learners has three sub-activities, namely, prototype submission, its evaluation by other groups of learners, and prototype re-submission. Getting into an even lower abstraction level, it is necessary to decompose some activities until atomic ones and detail the kinds of interdependency that exist among these activities.

When working with "conventional" workflows, the non-execution of a previous activity by the person who is supposed to do that implies that the workflow stops in a certain state. In the ITAE course, there is an additional timing factor that determines when an activity will be declared finished. For example, if a learner does not appear

in the face-to-face class, her workflow begins in the second activity. This unusual characteristic in workflow settings is essential to keep the course dynamics and indicates that the use of workflows in e-learning systems requires especial flexibility features.

Returning to the course workflow, Fig. 4a presents the expanded workflow for the weekly seminar activity. This activity involves three roles. The mediator (teacher) selects the learner that will play the seminar leader in that week and initializes the seminar session. The leader must then submit the seminar message to the conference and propose a number of questions to be discussed. The discussion takes place by means of message submissions by the learners to the conference. Each of these messages is evaluated by the mediator, who may also finalize the session.

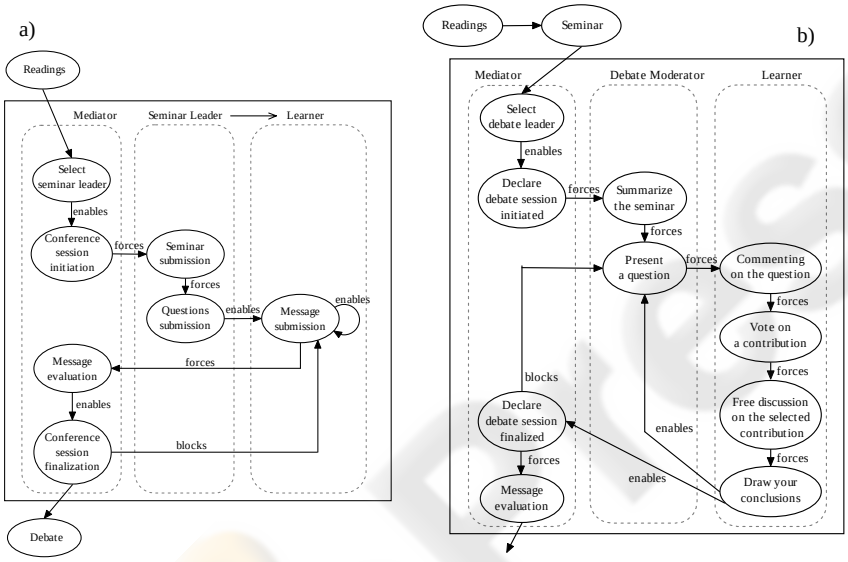

Fig. 4. a) Expanded workflow of a seminar. b) Expanded workflow of a debate

In Fig. 4a there are also indications of the kind of interdependency among activities, expressed by *enables*, *forces*, and *blocks* operators. An example of *enables* relation takes place between the leader's question submission and the learners' message submission. Learners are not able to submit messages before the leader's questions, but these questions do not oblige each learner to submit messages. Actually, the non-participation of a learner may have a negative impact on her degree, but this does not harm the procedural flow of the seminar. Other activities are connected with a stronger relation. For example, the session initialization by the mediator *forces* the leader to submit her seminar, followed by the questions, otherwise the seminar would fail. The *blocks* operator is also used, indicating that learners cannot submit messages after the mediator finalizes the seminar session. This doesn't imply that the mediator won't be able to continue evaluating the remaining questions. The mediator must evaluate all questions; some of them may be evaluated after the seminar finalization.

The examples of Figs. 3 and 4a show that the teacher should model the course activities, specifying the services, learners and sub-activities involved. An activity may comprise several sub-activities, different participant roles, and also different services. This is not an easy task, but it is important not only to enable the course coordination, but also to offer a pictorial view of the course dynamics, facilitating its re-design. Once the course is modeled, it will be straightforward to modify its dynamics.

Another important feature that will be obtained with the use of a workflow based coordination approach within AulaNet is the possibility to create different workflow paths for different learners or groups over a single course. For example, a more advanced class may skip introductory contents, while novices should study them.

4.1 Case Study: Coordinating the Debate

On ITAE debates, one participant is selected to play the role of moderator, with the job of coordinating other participants and presenting topics to be discussed about the subject that was studied during the previous activities. On recent classes of ITAE, a well-defined sequence of activities has been used on debates (Fig. 4b). The mediator declares the debate session initiated. Then, the moderator summarizes the seminar and formulates the first question. Next, each participant sends a message commenting on the question. After all participants sent their comments, they choose which one must be discussed. Then, everybody got involved in a free discussion about the selected comment. Finally, they draw their conclusions. This cycle—question, comments, vote, free discussion and conclusions—is repeated for each question presented on the seminar. Then, mediators finalize the debate and evaluate learners' participation.

To apply this dynamics, "Mediated Chat 2.0" tool was developed [10], implementing some group conversation techniques: *circular contribution*, where the participants are organized in a queue and each participant sends a message when it is her time in the line (used on "Commenting on the question"); *single contribution*, where each participant must send a single message and the message can be sent at any time without order (used on "Vote on a contribution"); and *free contribution*, where any participant can send a message at any time (used on "Free discussion" and "Conclusions").

The Mediated Chat 2.0 tool was a first step in introducing workflow like coordination techniques within an AulaNet service. This experience was important not only to show the potential of such technologies to prescribe user activities, but also to confirm that the new coordination paradigm generates unexpected situations that requires flexibility of the coordination mechanisms.

Frequently, on traditional chat tools a participant breaks up text to be sent into several messages—this resource generally is used to increase the dialogical potential and reduce the chat response time. Therefore, in the beginning on the use of Mediated Chat tool, some messages were sent with incomplete text, and the sender was not able to send another message completing the text, on account of the fact that the single contribution or circular contribution conversation techniques were in place. This feature of the tool, although generating some problems at the beginning of the first debate, was quickly understood and the participants developed strategies to conform to the well-defined conversation protocols imposed by the tool.

Some problems also occurred while using the *circular contribution* conversation technique. Some participants reported difficulty in identifying their position within the queue, even though the tool makes this information available to the user—what reinforces that the users must have clear awareness elements that enable them to quickly know the current workflow state.

Another problem happened when the person in the top of the queue takes a long time to write her message, causing the entire group to wait. In this situation, the mediator has to call her attention to complete the message and unblock the next contribution. This situation shows the importance of the social protocol even when the dynamics of the activity is well defined.

Finally, another observed fact is that the last participants to contribute tend to submit long messages, because they have more time to elaborate their texts. This results in atypical elaborated messages in a chat conversation. This fact indicates that the use of workflow techniques, although organizes the activities sequencing, may uncharacterize or make inadequate the realization of an activity. This reinforces that workflow like coordination mechanisms requires a careful introduction in the real world.

It is important to note that some of the aforementioned problems happened because the chat interaction is a loosely coupled collaborative activity. Other activities, like the Lesson Plan, are more structured, been more suited to a workflow based approach.

5 Conclusion

The coordination approach presented in this paper is a first effort to “embed” part of the social protocol that governs the interaction between mediators and learners within AulaNet. This workflow-based approach basically offers a pre-defined task sequencing, which aims to help learners to process the knowledge available on the course. Another potential use of workflow technology within AulaNet is as an abstraction to represent the course dynamics. The synthesized representation of the activities flow helps the coordinator to re-design the course. Moreover, it makes it possible to define different sequences for different learners or groups of learners within the same course.

Another coordination approach, which is also being implemented within AulaNet, is an activities monitoring mechanism proposed by SCORM (Sharable Content Object Reference Model) [1]. While the workflow approach aims to enforce the proper way of fulfilling the courses activities, the monitoring approach, as the name says, aims to check if some milestone was reached. The former is based on events, proactive, while the latter is passive, based on content navigation.

Finally, although the use of workflow technology somehow restricts the paths to be followed, it is important to stress that there is still room for the unstructured coordination based on the social protocol. As previously stated, both unstructured awareness based coordination and rigid workflow like coordination protocols have their importance in an e-learning environment. The challenge is to offer coordination

mechanisms that enable a guided knowledge acquisition without reducing the learners' possibilities within the e-learning environment.

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