
SECTION 4:

Conclusions and Future Work

Finally, the conclusions about the integration of collaborative activities in adaptive web-based environments, as well as the current work and the questions and open lines that arise from this proposal are presented. Some conclusions are open questions which lead to future research lines. Because of this strong relationship among them, they are presented together.

The main conclusion of this work concerns the benefits of combining adaptation and collaboration technologies in a merged way. As it was mentioned in the state of the art, there exist only a few educational systems that include both adaptation and collaboration capabilities, and they do not exploit all the benefits of the integration of both of them. The proposal presented in this work shows the **feasibility of integrating adaptation techniques and collaboration tools, taking advantage of this synergy and of the powerfulness of both technologies.**

The main advantage of the mechanism presented is its capability for generating adaptive web-based courses in which it is possible to adapt both the course presentation for each individual student and the collaboration issues. **Collaborative activities can not only be integrated in the courses, but also adapted** by considering the student's personal features, preferences, achievements and behaviours.

Starting from a unique course description supplied by the course developers, personalized courses are dynamically generated for different students, by including/removing activities or groups of activities, and by setting their sorting and compulsoriness. Concerning the adaptation of collaboration aspects, different students can be presented with the same collaborative task at different times. The requirements for a task to be available can also be different for dissimilar students. Furthermore, some collaborative tasks can be proposed only to specific students. When a certain number of students are ready to accomplish a collaborative activity, they are dynamically grouped into subgroups, depending on their personal features and achievements. For each collaborative task, the specific problem to be solved can be selected for each particular subgroup among those related to the same task. For example, depending on the knowledge already acquired by the students, and taking into account the difficulty of the problem statements associated to a task, it is possible to select the most suitable one for each group of students. The selection of the problem statement depends on the characteristics of each statement available and on the group features and achievements while learning the involved subjects. Finally, the collaborative workspaces to support the interaction between the students when accomplishing each collaborative activity are dynamically generated by joining the

corresponding problem statement and the tools to support the communication between the students. These tools can also be selected depending on the features and needs of each group, so that each group of students can feel comfortable while working through the collaborative workspace.

The evolution of the students during the learning process can determine the collaborative activity to be presented to them. Moreover, the accomplishment of a collaborative activity can affect to the later activities (individual and collaborative ones).

The only **requirement to exploit these adaptation capabilities** is to specify the group formation criteria, the course-structure rules, the collaborative-workspace rules and the collaborative-tool rules, specifying the types of users each rule is intended for. An advantage of this approach is that the course developer does not need to implement specific workspaces for each collaborative task. In the simplest case, he only needs to provide the problem statements, to select the tools among the available ones and to specify the type of students they are oriented to. In the case there is a need for a specific collaborative tool, it is also possible to include it.

Furthermore, the separation of course contents, structure, problem statements and collaborative tools facilitate the reuse and maintenance of components. It is easy to add, remove or modify a collaborative task, a set of tools to be used in a workspace or a problem to be solved collaboratively. In the same way, collaborative tasks can be easily moved from one point of the course to another, and prerequisites for a task to be proposed can be simply changed. It is also very easy to modify a course according to new needs detected. In general, new adaptation requirements can be implemented adding or modifying rules.

However, the integration of adaptation and collaboration presents some **hitches and open questions** that will be broached in the future.

In the area of the adaptive collaborative courses, the number of students who forms a group may depend on the context in which the course will be used, the user model, the time limits, the nature of collaborative activity and so on. For example, if it is widely offered for long-life learning, it is probable for the students to be very different. Moreover, they may connect to the courses at completely different moments. Even it is possible for some users to access to the course only with consultation purposes. On the contrary, if the course is used as an additional support to traditional lectures, it is very probable that the users take the whole course in a delimited time frame. The number of students participating in a course and the course duration may also determine collaboration issues such as the need of establishing deadlines for collaborative task resolution or the minimum/maximum number of students for each one of groups.

Conclusions and future work

The context must also be considered in order to take decisions about the student group formation and the way of solving or avoiding undesirable situations such as:

- Which are the best criteria for grouping students?
- Is it convenient to group students automatically according to certain established criteria or is it better to let the students group themselves?
- Should roles be established? Would the teacher be involved?
- When a student has waited too long for his partners to participate: Should the system send a warning to the students? When? What is “too long” in each context?
- When students have been waiting too long to be grouped: How long should they wait, as maximum? Should they be incorporated to recently formed groups? Should new groups be formed with several of these students, although the new groups do not satisfy all the defined criteria for student grouping?
- When a student leaves the course: Should his partners wait for other students to be ready to join them or is it better for them to join recently formed groups?

In order to satisfy the users' needs while interacting with others in different contexts it would be convenient to implement a mechanism for dynamically changing the criteria used for student grouping, depending on the context in which the adaptive course is used.

Finally, the main question to be answered is: In which contexts does the inclusion of collaborative activities in adaptive web-based courses improve the learning process? In order to get the best answers to all these questions and to obtain the best criteria for integrating collaboration activities in adaptive web-based courses, experiments with different real students in different contexts will be done. They will provide us feedback about the way students and groups interact within adaptive collaborative environments and also about their possible needs during the whole learning process. An analysis of these data would give rise to conclusions about the best criteria for grouping students depending on the context in which the course is used, or about the benefits obtained by the students while participating in collaborative activities that have been adapted to their personal needs and features. These data will be used to configure the default options in the develop phase, which are suitable of being changed by the teacher, if desired.

Currently, we are working in the development of an **authoring tool** that facilitates the specification of collaborative activities and collaborative workspaces (collaborative-workspaces rules and collaborative-tools rules). We are also **adding collaborative activities to existing courses**, so that in the near future we can do the **experiments** mentioned above.

In spite of the difficulties that this type of work faces at present, it is clear that the international community is starting to pay attention to the possibilities of bringing together adaptive and collaborative applications. This fact is highlighted by the celebration, for the first time, of the workshop “Adaptive Hypermedia and Collaborative Systems” that will take place at the “International Conference on Web Engineering” in Munich in July 2004.