Authoring Collaborative Graphical Editors for Adaptive Context-based Learning Environments

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Abstract. This paper presents an authoring tool that supports the specification of different collaborative activities and the configuration of collaborative graphical editors to be incorporated in dynamically generated collaborative workspaces. This tool allows teachers to reusing existing elements and multimedia material, and also saves them from learning the details about the underlying software. Collaborative workspaces are dynamically generated at run-time to support the accomplishment of collaborative activities by students. These activities can be incorporated into adaptive context-based learning environments, such as CoMoLE, which proposes each student the most suitable individual and collaborative activities according to her personal features, needs and context at each time, and supports their accomplishment.

Keywords: context-based learning, collaborative editors, authoring tools, CSCL

1 Motivation

The number of people that uses mobile devices to connect to the Internet from different places is exponentially increasing. This fact has motivated the development of mobile learning environments in which students can access to different learning resources and accomplish different activities though diverse devices [1][2][3]. User context (device, location, available time) can influence the accomplishment of learning activities. It would be inappropriate to propose complex collaborative activities to students when they have not a suitable device to accomplish them (i.e. if they are using their PDA or mobile phone), when they have not enough available time, or when their partner/s are not connected at the same time, in the case of synchronous collaborative ones. Context-based adaptation techniques support the

selection of the most suitable activities according to the current user's context in mobile learning environments [4].

Regarding collaborative learning [5], during the last years many collaborative tools and systems have emerged, such as the one described in [6] for *Computer Programming Learning*. A selection of systems supporting collaborative learning interaction management is presented in [7]. Concerning adaptation in CSCL, some works have been done, such as [8] [9] or [10].

Designing and developing collaborative learning environments is not an easy task. Focusing on synchronous collaborative editors, it is a fact that, on the one hand, managing issues such as synchronism or concurrency is pretty hard. On the other hand, describing collaborative activities in terms of computer software, organising the work groups, as well as developing the multimedia materials to be used for task accomplishment (not only those used by the teachers to illustrate the activity, but those used by the students to represent the solution) also requires a lot of effort. For these reasons, we consider convenient to provide solutions that: i) are transparent to teachers regarding low-level collaborative issues, and ii) gives them the possibility of either creating or reusing already defined activities, text wordings, multimedia elements, icons to be used during the collaboration, etc., and including them in the graphical editor. In this way, they do not need to start from the scratch when specifying new collaborative workspaces, but can take advantage of elements stored. Furthermore, taking into account that maybe not all the activities are suitable of being accomplished by every user at each time (because of the user context), it would be more appropriate to generate different collaborative workspaces and to select the activities to be tackled according to their current context.

The work presented in this paper focuses on helping teachers to specify different collaborative activities to be performed through dynamically generated workspaces that include collaborative graphical editors. Our main goal is to support, on the one hand, design and specification of collaborative workspaces including graphical editors by non technical experts and, on the other hand, dynamic generation of these workspaces starting from the teachers' descriptions, taking into consideration the students connected at a certain time and their context.

This paper is structured as follows: the bases of our approach are presented in section 2. The authoring tool developed to support the specification of collaborative workspaces and the reuse of activities and multimedia materials is described in section 3. Dynamic generation of collaborative workspaces is explained in section 4. And, finally, conclusions and future work are presented in section 5.

2   The Approach

The main goal of the approach presented in this paper is to support: i) dynamic generation of collaborative workspaces in which activities are performed through collaborative graphical editors, and ii) the realization of the most suitable collaborative activities through the graphical editors. These editors are created once at design time and configured at runtime according to the activities to be supported. The purpose is to support the generation of editors with specific icons to build a solution

for a certain problem (i.e., if the problem consists of building a logical circuit, the icons to be used to represent the solution to the problem will be logical gates with linkers to connect them). The collaborative editor toolbar is made up of elements, as well as links to mark the relationships between them. With the purpose of supporting the creation of this type of editors, an authoring tool has been developed. An application to support dynamic workspace generation has been implemented too.

The authoring tool helps teachers to specify the activities to be accomplished through collaborative graphical editors, as well as to describe the editor features. When creating a new activity, teachers must: i) provide the wording that describes the activity and ii) specify the features of the collaborative graphical editor to be offered to the students to support their collaborative work. Teachers can reuse, insert, modify or delete each of these elements, create workgroups and, in such a way, create different collaborative workspaces.

When collaborative activities have been described through the authoring tool, different collaborative workspaces are dynamically generated for each student at each time. The application developed generates each workspace starting from its description and also from the information about both the students that want to interact through it and the activities in which they are involved. The collaborative workspace presented to each student includes a list with the collaborative activities to be performed by her. When she selects one of them, the workspace is modified accordingly, in order to provide the corresponding collaborative graphical editor, which includes the activity wording, the icons to be inserted by the students in the shared work area to compose the solution and the shared work area itself. Next, the details of authoring tool and the dynamic generation of workspaces are explained.

3   Authoring Tool

The authoring tool is focused on helping teachers to define collaborative activities to be proposed to students when interacting with context-based adaptive environments. These activities, that will be selected according to the user's context at each time (device, available time, location), will be accomplished though collaborative graphical editors. The activities can be related among them, giving rise to sets of activities related to a certain subject.

A collaborative activity is defined by its attributes: i) name; ii) short description; iii) wording describing the activity, specifying the problem to be solved by students or the activity to be done; iv) icons to be used when performing the collaborative activity (images or pictures representing elements and linkers between them, to be included into the shared work area by the students to represent the solution of the problem); and v) deadline, indicating when the collaborative activity should be finished.

Teachers can take different actions though the authoring tool, such as adding, changing and removing elements (activities, problem wordings, icons, students and workgroups). When using this tool, they must choose between creating a new set of activities and managing an existing one. In the following subsections, the actions to be performed in order to create a new set of activities are explained in detail.

3.1 Defining Sets of Collaborative Activities

When a teacher wants to propose a new set of collaborative activities to the students, she must create a new *set*, in which she can define several *topics*. Each *topic* can contain one or more collaborative activities. In order to create a new collaborative activity, the teacher must select the corresponding *set* and *topic*, and provide both the wording of the problem to be solved and the components to be used for representing its solution in the configurable collaborative graphical editor (icons). When creating an activity, the teacher must give value to its attributes through the corresponding interface. The number of components to be used in each activity can vary. The teacher must either provide new icons/images or select them from those stored in the system (used in previous activities and uploaded by any teacher previously).

When a new activity has been created, the authoring tool gives the teacher the opportunity of managing and interacting with it by: i) modifying the activity wording and the icons/images associated with it, ii) deleting collaborative activities, and, more interesting, iii) simulating the collaborative workspaces that will be dynamically built.

In figure 1, a snapshot of the authoring tool is presented. In the left half of the interface it is shown how the teacher creates new collaborative activities. As it can be seen, three activities have been defined. The first one, *Logical Circuits with AND, OR and NOT gates*, (the *active* one at this time) has four icons associated. Three of them correspond to logical gates. The fourth represents a linker to be used to connect logical gates. The buttons situated at the bottom of the interface allow teachers to adding and deleting activities to the list. The buttons at the upper left-hand side of the page allow teachers to accessing to the main menu, as well as to adding new icons to the active activity.

3.2 Collaborative Workgroups

The next step of the design phase consists of specifying the workgroups involved in the different activities. For instance, let us suppose that a teacher creates three different collaborative activities (Actv1, Actv2 and Actv3) for three students (St1, St2 and St3). Activity Actv1 will be proposed to students St1 and St3. Activity Actv2 will be performed by students St1 and St2. And activity Actv3 will be accomplished by all the students. In this situation, student St1 will be involved in the three collaborative activities, while students St2 and St3 will be proposed with two different activities from the three activities belonging to the same set. The workspaces to be generated at runtime will contain the corresponding list of pending activities for each user.

It is also possible to associate diverse roles to students in each workgroup. In this application, two roles have been defined: team-leader and regular-member of the group. If a student has the team-leader role associated in a certain activity, he has the privilege to mark this activity as finished. A student can be team-leader in a certain group and regular-member in other workgroups. If homogeneous groups are desired, the team-leader role can be associated to all the group members. In the low right-hand side of figure 1, a snapshot of the workgroup creation interface is shown (over the main interface snapshot).

Although groups are currently formed by teachers, automatic-grouping mechanisms can also be incorporated, such as those developed previously [10], in which different grouping criteria can be used [11].
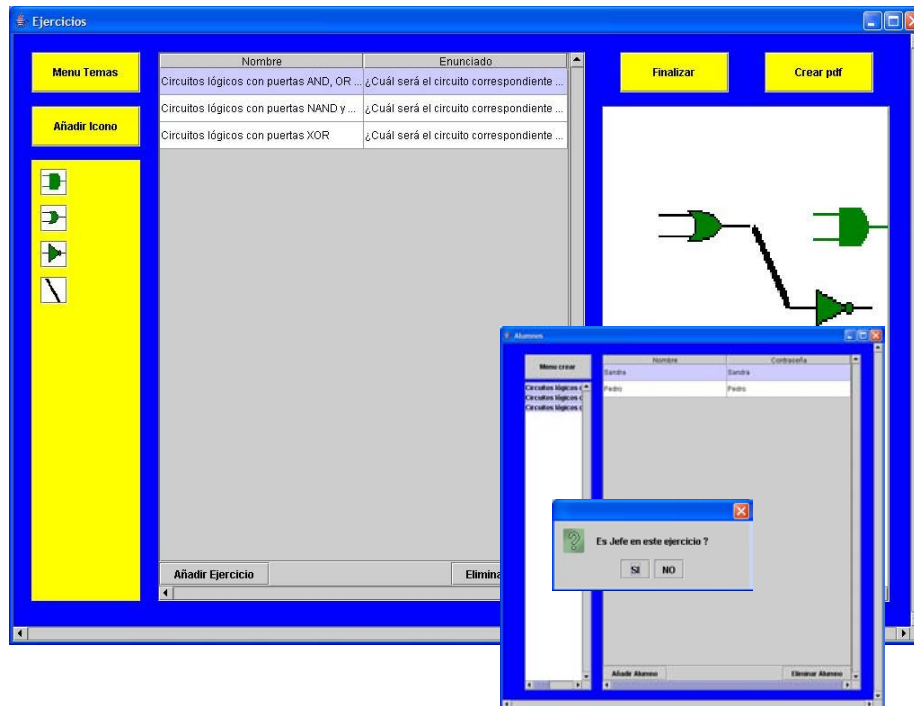

Fig. 1. Authoring tool: editing and monitoring

4 Dynamic Generation of Collaborative Workspaces

Once collaborative activities have been defined and workgroups have been established, students can start to accomplish the activities in which they are involved. When a student accesses to the application that supports the accomplishment of collaborative graphical activities, a workspace is dynamically generated. This workspace is composed by five areas (see figure 2), each of them containing:

- List of the collaborative activities to be performed by this student, presented in area one (see ① in figure 2).
- Statement or wording of the activity selected by the student, presented in area ②.
- Shared working area with the collaborative graphical editor, placed in the main area (③ in figure 2).
- Toolbar, including components (icons and images, representing elements and linkers) to be used for composing the solution of the collaborative activity. Other

icons, such as hand-icon, resize-icon and close-icon, are also included in this bar to allow the student to, respectively, moving, resizing or deleting elements and linkers in/from the collaborative workspace. For team leaders, the finish-icon is also included to allow them finishing the collaborative activity. All the components are part of the toolbar on the left side of the collaborative workspace (④ in figure 2).

– Finally, information messages sent by the application to connected users are presented at the bottom of the interface, in area ⑤.
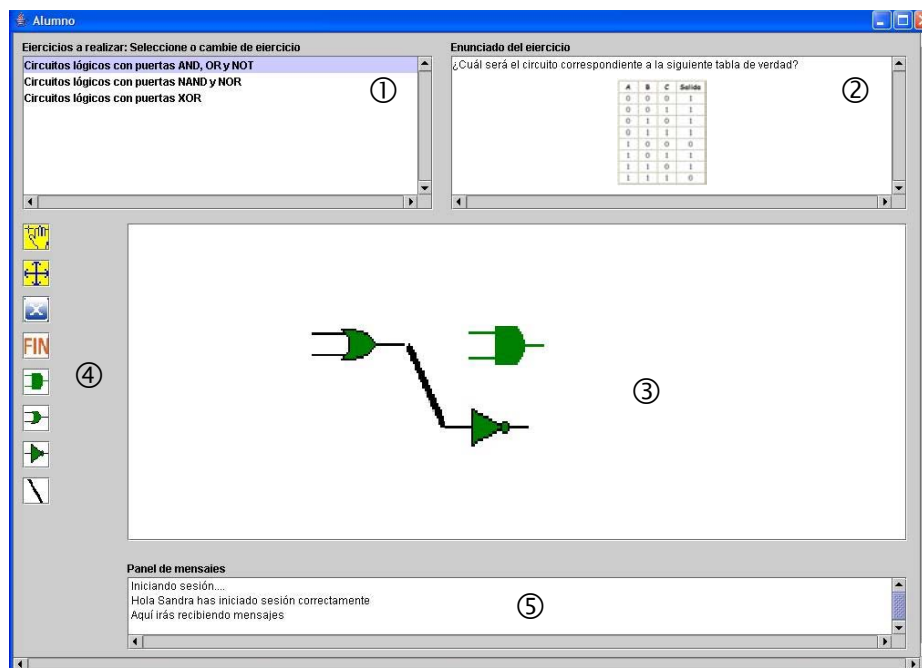

Fig. 2. Example of Collaborative Workspace Generated

Initially, the information presented in this page (problem wording and components to be used) is related to the first activity of the list of student pending activities. If the student wants to work in another activity, he must choose it from the list of activities presented in area ①. Then, the wording of the problem selected is presented in area ②, the icons related to this activity are presented in area ④, and the current state of the activity is loaded in the main area of the interface in the collaborative shared work area ③.

This application manages all the actions performed by students in different workspaces, and stores the state of the shared work area for each activity and workgroup each time a change is made. When a student moves from one activity to other, the application checks the current state of the second task and presents it to the student, including the work developed by all the members of the same workgroup until that precise moment.

When performing a collaborative activity, students can take the following actions: i) inserting a new element in the collaborative workspace, ii) selecting, moving or resizing one element from those already included in the shared work area, or iii) deleting one of the elements already included in the shared area.

The results of each action are immediately shown to all the group members. Students connected to the application receive feedback about both the actions performed by their partners and their connection status in the message area, situated at the bottom of the page (see area ⑤ in figure 2).

Team leaders can annotate an activity as finished by clicking on the finish-button. When taking this action, all the group members receive a message in area ⑤ and a popup window is opened to inform them that the task is finishing within five minutes, since a new and close deadline has been established by the team leader. When this period of time passes, the activity is marked as finished and no member of the group can modify the solution to this problem. Apart from team leaders, teachers can also decide the ending of activities. They can also take other actions such as monitoring the students' actions, looking at the content of the shared work area or generating a PDF file with the evolution and result of each activity (see right-hand side of the tool main interface in figure 1).

Figure 2 shows an example of a collaborative workspace generated for a student who plays the team-leader role in activity *Logic Circuits for AND, OR and NOT gates*. As it can be seen, the problem statement related to the first activity, is shown in area number ②. Icons representing logical gates are available in the tool bar, as well as icons to move, resize or delete components (area ④). As this student is the team-leader, the finish-button is also included. In the main area (number ③), the current state of the activity is shown. At the bottom of the page (area ⑤), the messages of the interaction with other members appear.

The implementation of the authoring tool and the application to support dynamic workspace generation is Java based. A specific package has been developed to control concurrency; it models the producer-consumer problem and implements the reader-writer problem when two students are interacting at the same time. Library iText has been used in order to support the generation of PDF files from the information stored about the solutions provided by the students. The content of these PDF files can be evaluated by teachers.

5   Conclusions

The work presented in this paper supports design and dynamic generation of collaborative workspaces including configurable graphical collaborative editors to support the realization of different collaborative activities in different contexts.

The authoring tool described in the paper helps teachers to create collaborative activities in an easy way by supporting both the configuration of graphical editors to be used for each activity and the reuse of multimedia material associated to previous collaborative activities (problem wordings and graphical elements), reducing the time teachers spend in this labor and also saving them from learning the details about the underlying software.

The activities designed through this authoring tool can be incorporated into CoMoLE [12], a context-based adaptive mobile learning environment able to recommend the most suitable individual and collaborative activities to be accomplished by each student at each time according to her preferences, needs and, particularly, context at that time (location, available time and devices). Regarding the adaptation of collaborative activities, it is possible to adapt the problem or activity proposed, as well as the collaborative workspace to work on, according not only to the student context but also to, i.e., her preferences or learning style.

References

1. Verdejo, M.F., Celorrio, C., Lorenzo, E., Sastre-Toral, T.: An Educational Networking Infrastructure Supporting Ubiquitous Learning for School Students. In: Kinshuk, Koper, R., Kommers, P., Kirschner, P., Sampson, D.G., Didderen, W. (eds.) 6th IEEE Int. Conference on Advanced Learning Technologies, pp. 174-178. IEEE Computer Society (2006)
2. Zimmermann, A., Specht, M. and Lorenz, A.: Personalization and Context Management. User Modeling and User-Adapted Interaction, 15, pp. 275-302. Springer (2005)
3. World Conference on mLearning, mLearn, http://www.mlearn2006.org/
4. Martín, E., Carro, R.M., Rodríguez, P.: A Mechanism to Support Context-based Adaptation in M-Learning. In: Nejdl, Wolfgang; Tochtermann, Klaus (eds.) Innovative Approaches for Learning and Knowledge Sharing. LNCS, vol. 4227, pp. 302-315. Springer (2006)
5. Dillenbourg, P.. Collaborative learning: cognitive and computational approaches. Elsevier, Oxford (1999)
6. Bravo, C., Marcelino, M.J., Gomes, A., Esteves, M., Mendes, A.J.: Integrating educational tools for collaborative Computer Programming learning. Journal of Universal Computer Science, 11 (9), pp. 1505-1517. Know Center, Springer Verlag (2005)
7. Soller, A., Martínez-Monés, A., Jermann, P., Muehlenbrock, M..: From Mirroring to Guiding: A Review of State of the Art Technology for Supporting Collaborative Learning. International Journal of Artificial Intelligence in Education, 15 (4), pp. 261-290 (2005)
8. Furugori, N., Sato, H., Ogata, H., Ochi, Y., Yano, Y.: COALE: Collaborative and Adaptive Learning Environment. Proceedings of CSCL 2002, pp. 493-494 (2002)
9. Gaudioso, E., Boticario, J.G.: Supporting personalization in virtual communities in distance education. In: Jain, L.C., Howlett, R.J. (eds.) Virtual Environments for Teaching and Learning. World Scientific Publishing Company Pte Ltd., pp. 327-362 (2002)
10. Carro, R.M., Ortigosa, A., Martín, E., Schlichter, J.: Dynamic Generation of Adaptive Web-based Collaborative Courses. In: Decouchant, D. and Favela, J. (eds.) Groupware: Design, Implementation and Use, LNCS, vol. 2806, pp. 191-198. Springer-Verlag (2003)
11. Alfonseca, E., Carro, R.M., Martín, E., Ortigosa, A., Paredes, P.: The Impact of Learning Styles on Student Grouping for Collaborative Learning: A case study. User Modeling and User-Adapted Interaction, Vol. 16, 3-4, pp. 377-401. Special Issue: User Modeling to Support Groups, Communities and Collaboration. Springer Netherlands (2006)
12. Martín, E., Carro, R.M., Rodríguez, P.: CoMoLE: A Context-based Adaptive Hypermedia System for M-Learning. In: Procs. of VIII Simposio Nacional de Tecnologías de la Información y las Comunicaciones en la Educación at CEDI 2007. In press (Sep 2007)