In: Nolte, A.; Prilla, M.; Lukosch, S.; Kolfschoten, G. and Herrmann, T.: Proceedings of the 1st International Workshop on Collaborative Usage and Development of Models and Visualizations at the ECSCW 2011 (CollabViz 2011)

Collaborative diagram drawing: a case study on scaffolding self-regulated behaviors

Ilaria Manno, Giuseppina Palmieri, Vittorio Scarano
ISISLab, Dipartimento di Informatica, Università di Salerno, Italy
manno@dia.unisa.it, palmieri@dia.unisa.it, vitsca@dia.unisa.it

Abstract.

In this paper we present a case study of collaborative diagram drawing involving 36 students in Computer Science. Their task was to collaboratively draw a Use Case Diagram about the scenarios provided at the begin of the experiment. As students of a Software Engineering course, they had a general knowledge of such type of diagrams and related terminology, but they were not experts and had not real and practical experiences in diagram drawing. The tools used were a synchronous collaborative drawing tool integrated with a chat tool to support communication among the participants. Moreover, the experiment has been structured following the 'think, pair, share' method. The analysis of the collaboration process outlines a twofold result: first, a significant equal participation of all the students and second, an implicit and recurrent self-regulatory behavior employed by the students to create and refine the diagram and to reach agreement about the final result.

1 Introduction

The collaborative creation of diagrams is commonly used in brainstorming processes, development of models, problem solving processes and, in general terms, in the creation of shared knowledge and understanding. This activity is used also in the educational setting to support collaborative learning. Indeed, in educational settings the aims are different from the working setting: students are responsible for one another's learning as well as their own, thus, the success of one student helps other students to be successful. Therefore, the aspects about the users'participation and the self-regulated behaviors become particularly important: the free-riding behavior of some students de-motivate the other students and, then, the overall team

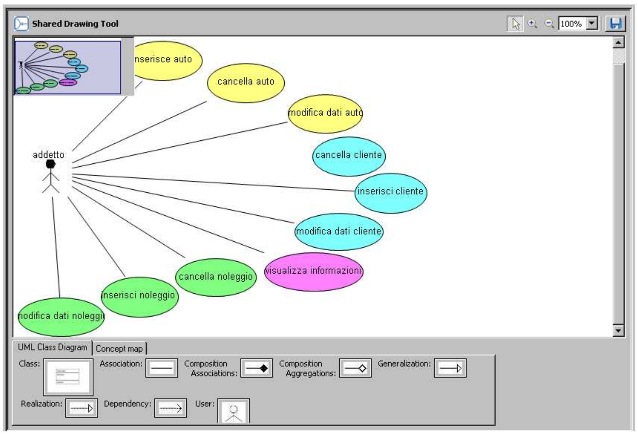

Figure 1. SDT screenshot showing the creation of a Use Case Diagram..

performance decreases (Ruël et al. (2003); Maldonado et al. (2007)).

In this paper we present our evaluation of an experiment of collaborative diagram drawing in a Software Engineering course. We have used a chat and a tool (the Shared Drawing Tool, SDT) for collaboratively drawing of Use Case Diagrams. Both the tools are integrated in the CoFFEE platform, which offers also the possibility to structure the collaboration in customized phases. In the analysis of the experiment we have found that all the students participated with a similar engagement and effort, and by using effectively the tools.

2 The experiment

Our experiment has been conducted in collaboration with the University of Basilicata (Erra et al. (2010)). It involved 36 students of the Software Engineering course; they had a general knowledge of such type of diagrams and related terminology, but they were not experts and had not real and practical experiences in diagram drawing. Their aim was to draw collaboratively a Use Case Diagram about some tasks proposed by the teacher. The experiment was designed so that half of the students worked in face-to-face (f2f) condition without the computer support and the other half worked in a (simulated) computer supported remote condition. Then, the two groups repeated the experiment in the opposite conditions. Erra et al. (2010) evaluated the diagrams and they found that, while the f2f setting needs less time to complete the work, the diagrams quality is slightly better in the computer supported condition. An early analysis of this experiment about students involvement focused on the reduction of the free-riding effect and found a significant equal participation among all the students (Belgiorno et al. (2010b)). Before presenting the data analysis, we briefly describe the software system used and the setting of the experiment.

The groupware used is CoFFEE (Collaborative Face-to-Face Educational Environment), a set of applications aiming to enhance the computer supported collaborative learning in f2f setting. In this experiment, we have simulated a remote condition: the students were in the same classroom but were grouped and seated so that they could not have f2f interactions. The main applications are the CoF-

FEE Controller and the CoFFEE Discusser, used in classroom respectively by the teacher and the students. These applications offer several collaborative tools which can be arranged together following the specific path designed preliminary by the teacher (De Chiara et al. (2007)). We have used the Shared Drawing Tool (SDT), a graphical tool integrated in CoFFEE to support the synchronous collaborative creation of graphs. The SDT offers a shared 2-dimensional space where the students can create figures and links, can move the existing items, and can edit his/her own contributions by changing the text, color, size, fonts (while editing contributions of other users is not allowed). The SDT provides also a direct support for creating concept maps and UML diagrams. A screenshot of the SDT is shown fig. 1.

2.1 The Experiment setting

The experiment involved 36 students in Computer Science of the University of Basilicata (27 Bachelor and 9 Master students). The assigned tasks were about a software system to manage *(a)* a library, *(b)* selling and rental of films, *(c)* a car rental, *(d)* an e-commerce platform to order CDs. The tasks were similar in complexity and were reasonable in relation with the preparation of the students. For each task the students were asked to provide a Use Case Diagram.

The collaboration through CoFFEE has been organized following the "Think, Pair, Share" method (TPS) to encourage students participation. The students were organized in groups of four people, and the activity was structured in three steps:
think, students work individually on the task to carry out; in this phase CoFFEE was configured to offer to each student his/her own istance of the SDT;
pair, students work in pairs on the task to carry out; in this phase CoFFEE was configured to manage groups of 2 persons and offer them the SDT and the Chat;
share, students work all together to produce a final solution; in this phase CoFFEE was configured to manage groups of 4 people and offer them the SDT and the Chat.

At each step, the results from the previous phase are copied onto the SDT workspace, so that the students can start the work of the new step on the basis of the previous one. The experiment generated 18 *traces*. A *trace* is an XML file where the Controller records all the events of a collaborative session: the chat messages, the shared drawing tool actions, clients connections and disconnections and so on. Two of the traces were corrupted so the data analysis is based on 16 traces.

3 Data analysis

A first study of the traces of the experiment aimed to evaluate the participation of students in the collaborative session by using the Gini coefficient (*Gc*) and it indicated that the participation among all the groups has been well balanced: the users who chatted more, drew less, and vice-versa, with no explicit agreement about the roles of the participants (Belgiorno et al. (2010b)).

We analyze, here, the experiment by looking at any pattern of coordination that can be found in traces. In general terms, the chat has been used as a mean to organize and coordinate the work on the diagram; moreover the usage of the chat and the contributions on the SDT are not totally casual: indeed, they present a regular

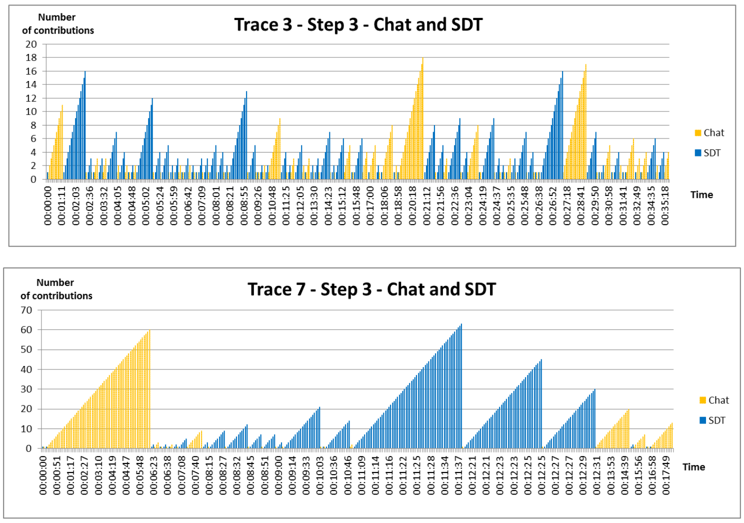

Figure 2. Above: the pattern A, with sequences of micro-phases involving chat and SDT. Bottom: the pattern B, with macro phases of chat and actions on the SDT.

pattern. In all the traces there is an initial phase in which the students use almost only the chat. This is due to the structure “think-pair-share” of the experiment: in the initial phase the students use the chat to describe the work that they have done in the previous step. After this initial phase, we found two kind of patterns, A (5 traces) and B (11 traces), which differ in the way of usage of the tools. In fig.2 we show the cumulative sequences of contributions on the chat and SDT.

The pattern A (top graphic of fig. 2) presents sequences of frequent chat messages followed by contributions on the SDT. In these traces, then, the coordination work goes through the whole phase as micro-coordination tasks.

The pattern B (bottom graphic of fig. 2) presents sequences of macro phases of many chat messages followed by macro phases of work on the diagram. In these traces, then, there are a well defined analysis and coordination phase followed by a wide phase of implementation of the work.

In the analysis of the patterns, we paid particular attention to the step 3 because it involves all the students in the work group, so we consider it as the most meaningful; however, most traces present the same kind of pattern (A or B) both in the steps 2 and 3 (we have not considered the pattern of the step 1 because, in the think-pair-share method, it is the step where each student *thinks* alone). It should be noticed that, in some traces, in the step 2, when the students are organized in two groups, one group presents the pattern A and the other group presents the pattern B; however, all of these traces present pattern B in the step 3. Therefore, the pattern B prevails on the pattern A and this could explain the greater number of traces of kind B. The students employed these pattern spontaneously: the teacher did not stimulate any behavior nor action, he was just responsible to pass from a step to the next one.

The patterns employed by the students seems to influence the level of re-using of the existing diagram through the several steps. As previously described, the structure of the experiment follows the “think, pair, share” method and in each step the

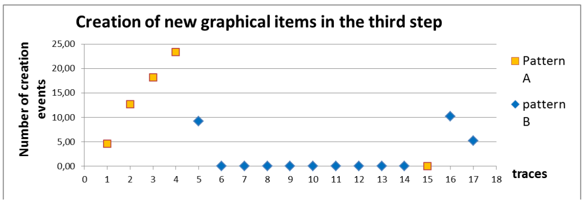

Figure 3. The traces with pattern B show few creation events on the diagram in the step 3, while the traces with pattern A show a meaningful higher number of creation events in the same phase.

students had the work of the previous step available as starting point. Then, the expectation is that at the third step most part of the diagram has been created and the students should work to organize and refine the final outcome by re-using the existing draw, with a minimal numer of creation of new items in the diagram. Indeed, the level of reusing of the existing diagrams and the number of new items created in the third step seem influenced by the pattern employed by the students: the groups adopting the pattern B create fewer items (mean 2,06% respect to the total actions on the SDT) than their colleagues employing the pattern A (mean 9,81% respect to the total actions on the SDT), as shown in fig. 3. This suggests that the students employing the pattern B, during the macro phases of work coordination, are able to optimize the work better than their colleagues and are able to achieve an higher level of re-using of the existing work.

4 Conclusions

In the collaborative usage and creation of diagrams it is fundamental supporting users' participation, reducing the free-riding effect and users' idleness as well as scaffolding self-regulated behaviors. We believe that a key factor is the integration of discussion and drawing tools in a seamless environment, so that the users can switch between the tools without any overhead, and the discussion and the drawing activities can converge in a single and natural collaborative flow. Moreover, we believe that, in the learning setting, it is fundamental the possibility to embed in the groupware a structure to drive the collaboration process: this allows to adopt well-known pedagogical strategies to enhance the students'engagement and learning performance. These ideas are supported by the analysis of the experiment that we have presented in this paper, which shows an equal participation of all the students and an effective usage of the tools to organize the work and create the diagrams.

We are aware that the conditions of our experiment (small groups, no facilitators or modellers, similar cultural background and modelling skills among participants) are very different from the business environment, where the modelling activity could involve larger groups, expert modellers, stakeholders with no modelling skills, and could require a severe check on the model quality (Renger et al. (2008)). Despite that, if the aim is to create a shared understanding among the participants, like in requirements elicitation or early phases of new projects, it could be more important supporting the participation and collaboration than a severe check of the model quality. In this direction it was oriented our work about the integration of collaborative tools in a software development environment (Belgiorno et al. (2010a)).

However, these cases require further analysis to evaluate if the creation of a shared understanding could be enhanced by an approach similar to our experiment: a system which integrates different tools could allow modelling skilled users to draw the diagram and no-skilled users to participate in the activity by using brainstorming tools. Moreover the participation could be supported by reducing the size of the groups through the management of subgroups, in order to reduce the necessity of a facilitator or a chauffeur. The convergence of subgroups through successive phases can have a twofold effect: the presentation of the ideas of each subgroup could highlight new sides of the treated problem and, at the same time, it is a double-check on the model to find and correct pitfalls (Frantzeskaki et al. (2008)).

Acknowledgments. The authors gratefully acknowledge the support by Andrea Guaiana during the development of Shared Drawing tool. The authors also thank the collaboration by Ugo Erra and Giuseppe Scanniello in setting up the experiment.

References

Belgiorno, F., I. Manno, G. Palmieri, and V. Scarano (2010a): ‘Argumentation tools in a collaborative development environment’. In: *Proceedings of the 7th international conference on Cooperative design, visualization, and engineering*. Berlin, Heidelberg, pp. 39–46, Springer-Verlag.

Belgiorno, F., I. Manno, G. Palmieri, and V. Scarano (2010b): ‘Free Riding in Collaborative Diagrams Drawing’. In: M. Wolpers, P. Kirschner, M. Scheffel, S. Lindstaedt, and V. Dimitrova (eds.): *Sustaining TEL: From Innovation to Learning and Practice*, Vol. 6383 of *Lecture Notes in Computer Science*. Springer Berlin / Heidelberg, pp. 457–463.

De Chiara, R., A. Di Matteo, Ilaria Manno, and V. Scarano (2007): ‘CoFFEE: Cooperative Face2Face Educational Environment’. In: *Proceedings of the 3rd International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom 2007), November 12-15, 2007, New York, USA*.

Erra, U., A. Portnova, and G. Scanniello (2010): ‘Comparing two communication media in use case modeling: results from a controlled experiment’. In: *Proceedings of the International Symposium on Empirical Software Engineering and Measurement, ESEM 2010, 16-17 September 2010, Bolzano/Bozen, Italy*. ACM.

Frantzeskaki, N., A. De Haan, G. Kolfschoten, and W. Walker (2008): ‘Three challenges, four pitfalls and five actions when teaching conceptual modelling’. In: *International Conference of Education, Research and Innovation, ICERI 2008*. International Association of Technology, Education and Development (IATED).

Maldonado, H., B. Lee, S. R. Klemmer, and R. D. Pea (2007): ‘Patterns of collaboration in design courses: team dynamics affect technology appropriation, artifact creation, and course performance’. In: *CSCL’07: Proceedings of the 8th iternational conference on Computer supported collaborative learning*. pp. 490–499, International Society of the Learning Sciences.

Renger, M., G. L. Kolfschoten, and G.-J. De Vreede (2008): ‘Challenges in collaborative modelling: a literature review and research agenda’. *International Journal of Simulation and Process Modelling*, vol. 4, no. 3/4, pp. 248–263.

Ruël, G. C., N. Bastiaans, and A. Nauta (2003): ‘Free-riding and team performance in project education’. Technical report, Research Report 03A42, University of Groningen, Research Institute SOM (Systems, Organisations and Management).