

A System for Collaborative Building of Use Case Models: Communication Analysis and Experiences

Experiences of Use and Lessons Learned from the Use of the SPACE-DESIGN Tool in the Domain of Use Case Diagrams

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Abstract: Over the past few years, a great deal of work has been done in the field of collaborative software (groupware). Many fields of science have taken advantage of these developments, and Software Engineering is one such field. Within this scope, we have developed a domain independent synchronous collaborative tool that can be specialized to work with several types of diagrammatical domains. Among those domains, the diagrams used in the Unified Process can be found. In this paper we describe how we have specialized this tool to work with use case diagrams and how we have carried out an empirical study with this tool to obtain conclusions regarding several issues: the analysis of three kinds of communication among users, the relationship between types of communication and coordination among users, and the relationship between communication and the quality of the modeling work.

1 INTRODUCTION

Currently, many fields in industry, research and education are taking advantage of the advances in collaborative software applications and systems. These applications have been classified in the so-called field of groupware (Guareis de Farias, 2002). Groupware is defined as those computer-based systems that give support to a group of people who work together on a shared task, and that provide an interface to a shared environment (Ellis et al., 1991). By means of computer networks and groupware systems, shared workspaces are created and group tasks of several kinds can be carried out.

Software Engineering is one of the fields that can take advantage of the boom in the groupware area. Specifically, many processes within the Unified Software Development Process require the participation of several actors with different or equal roles. Thus, such actors may create or modify the diagrams integrated in the Unified Modeling Language (UML) in a collaborative way. This leads us to the fact that a collaborative or groupware tool can assist in the development of such work and allow higher quality diagrams to be developed.

Another way in which groupware contributes to Software Engineering is collaborative programming, in which several programmers work on the same source code when solving problems (Bravo et al., 2013).

In this work, we focus in particular on the use case diagrams used during the Requirements Analysis phase. Within the tools that may support this activity, we have decided to work with synchronous collaborative tools. By means of these tools, several users who are physically separated are able to work on the same diagram at the same time. This is also known as real time collaboration in the literature. As explained in Section 2, the synchronous collaborative building of such diagrams using groupware tools is an area in which there is a lack of relevant works. In synchronous collaborative settings, participants are usually grouped in work sessions in which they work together on a given goal. In order to help the collaborative work be done, these tools should integrate several widgets or components for the support of communication and coordination among the members of the collaborative work session. Communication among the participants in a collaborative work session is a basic issue to be considered when carrying out the

tasks, as it is the most immediate way in which users can coordinate their work and solve possible situations of conflict that may arise during the session. In this work, we have focused our interest on analyzing the communication among users in a collaborative work session. As mentioned, the work to be analyzed is the synchronous collaborative use case modeling.

In order to analyze a group of users' behavior regarding communication issues, an empirical study is presented. We have analyzed the development of a collaborative work task in the domain of use case diagrams. This task has been carried out by using a synchronous collaborative tool. Thus, our goals in this study have been, on the one hand, to prove that the development of use case diagrams in a synchronous collaborative way by using a groupware tool is feasible, and, on the other hand, to analyze how the different possibilities of communication and coordination users were provided with have an effect on the process and also on the results of the work. In this sense, we have studied the results obtained during the work together with the actions of communication and collaboration performed by the members of the work sessions. The task carried out by the participants in the study is the building of a use case diagram starting from a requirements specification in natural language.

In order to conduct this study, a synchronous groupware tool that gives support to design and modeling in a specific domain is needed. The tool we have chosen to give support to our study is SPACE-DESIGN (Duque et al., 2008). SPACE-DESIGN is a domain independent synchronous groupware tool that can be specialized to a wide set of application domains by means of a simple process of configuration. In this case, we have configured the tool to support the development of use case diagrams.

The remaining part of this work is organized as follows: in Section 2, we deal with some systems and approaches related to the work described in this paper. Then, the SPACE-DESIGN collaborative tool is described. In Section 4, we explain the empirical study we have carried out in detail and we discuss the results obtained. Lastly, we present some conclusions and future work.

2 RELATED WORK

In this section, we tackle systems and technologies related to the work completed. Firstly, in Subsection 2.1 we discuss those tools that support synchronous

collaborative modeling in any domain. Afterwards, in Subsection 2.2 we mention some tools that are used for the development of use case diagrams.

2.1 Tools for Synchronous Collaborative Modeling

A few tools that support the synchronous collaborative modeling of diagrams and artifacts in several application domains exist. Some of them are specific of a given domain and some others are generic or domain independent, with this meaning that they can be adapted to work on different domains by means of a configuration process.

Some examples of domain independent collaborative modeling tools are Cool Modes and Synergo. Cool Modes (Pinkwart et al., 2001) is a cooperative modeling system that contains a workspace including a set of *plug-ins*. These plug-ins are actually palettes that contain the objects that can be placed over the shared workspace and the links to create relationships between the objects. In Cool Modes it is not possible for users to reconfigure or extend the functionality of the tool by adding new palettes that support new application domains. Synergo (Avouris et al., 2004) is also a tool for the design on a shared whiteboard. Synergo contains a predefined set of objects that can be placed on that whiteboard. This set cannot be extended. Another feature included in Synergo is a powerful communication system in the form of a chat for the discussion among the members of the work session. This chat includes the possibility of sending predefined messages that can direct the communication. Such messages usually deal with making proposals and accepting or denying them. Thus, Synergo introduces the concept of structured chat, about which we will talk later.

SPACE-DESIGN (Duque et al., 2008) is a synchronous collaborative modeling tool. It is reconfigurable and extensible. In order to configure it for a specific application domain, XML-based files are used. This tool includes some widgets for awareness and coordination support, which are implemented as reusable components. One of those widgets is a structured chat, as explained in Section 3. The presence of the chat is one of the main reasons for the selection of this tool for the empirical study. The usefulness of chats and similar communication mechanisms has been proved in diverse collaborative tasks (Lund et al., 1996), and specifically in requirements elicitation in software engineering (Calefato et al., 2012). In fact, we have used SPACE-DESIGN in our research group for

other works in which we have needed a synchronous collaborative tool (Gallardo et al., 2011). Of course, we have specialized SPACE-DESIGN in order to make it work over the use case diagrams domain. Other systems, such as the aforementioned Cool Modes and Synergo, could not have been configured in such a way. Further explanations about SPACE-DESIGN can be found in Section 3.

Now, we go back to the concept of structured chat. The usual way to support communication in synchronous collaborative tools is to include a chat that allows users to communicate to each other. The use of a chat is especially important in tasks such as creating artifacts or diagrams on a synchronous way, as it allows communication during the work sessions. A special kind of chat is the structured chat, in which users can use specific sentence openers that are used to have a more directed conversation. Usually, sentence openers are related to the specific domain of the tool.

Synergo and SPACE-DESIGN are examples of tools that include a structured chat. Another one is COLER (Constantino-González et al., 2001). This system is a web based collaborative environment for the learning of Entity-Relationship diagrams. Some other interesting tools that use structured communication are C-CHENE (Baker & Lund, 1996), which deals with the building of energy chains, and EPSILON (Soller & Lesgold, 2000), for object-oriented design with OMT diagrams.

2.2 Collaborative Tools for the Development of Use Case Diagrams

There exist several tools for the development of use case diagrams, both collaborative and non-collaborative ones. In the scope of our institution, Rational Rose and Visual Paradigm are the ones that have been used in the recent times, both of them being non-collaborative tools. Next, we are going to talk about some collaborative tools that have been developed in the scientific and commercial spheres.

In (Fuenzalida and Antillanca, 2010) two tools for the textual edition of use cases are described and compared. One of these tools is synchronous, whereas the other one is an asynchronous tool. Neither tool handles diagrams, but they allow the textual edition of the use cases and the relationships among them. The comparison between the tools is done by calculating some metrics. Most metrics give best values to the asynchronous tool, but the synchronous modeling seems to have some relevant advantages. For instance, it takes less time to obtain the final model.

Most existing systems that implement some kind of collaboration to edit use cases or to build use case diagrams actually implement an asynchronous collaboration. Even this collaboration is sometimes just a mere management of group work or a kind of version control system. Some tools implementing such approaches are CaseComplete (Serlio Software, 2013) or Visual Use Case (TechnoSolutions Corp. 2013). Another category is that of those tools that deal with software lifecycle in a wider sense and contain specific components for the management of use cases. This is the case of the Rommana system (Rommana Software, 2013). This tool includes requirements management, tests management and so on, together with a use cases management unit.

Thus, we can conclude that synchronous collaborative use cases modeling is a field that has not been explored enough and that can provide some advantages when carrying out the modeling tasks. In the same way, we understand that it is interesting to analyze the communication and coordination of the teams of analysts or engineers that perform the collaborative modeling, so that we can obtain some conclusions to improve the process. In the following section, the SPACE-DESIGN tool is described in detail. SPACE-DESIGN is the tool used to carry out the collaborative use case diagrams modeling in the empirical study described in Section 4. As mentioned in Section 2.1, this tool has been chosen because it presents some features that make it more suitable than other tools.

3 THE SPACE-DESIGN TOOL

The SPACE-DESIGN tool (Figure 1) is a system that is the instrumental part of a methodological approach for the model-driven development of collaborative modeling systems (Gallardo et al., 2011b). In particular, SPACE-DESIGN supports distributed synchronous work, allowing users to build models collaboratively. It is domain-independent since the system processes the domain specification, expressed by means of an XML-based language, and spawns the user interface and the necessary functionality to support that specific type of modeling, including specific interaction and awareness design aspects in the groupware user interface.

As shown in Figure 1, SPACE-DESIGN has a shared whiteboard (A) where users can work with the different elements that make up the application domain. These elements can be one of two types: objects (B) and relationships (C). Both types are

instantiated from the toolbars that are located on the left-hand side of the user interface (D, E). These toolbars will vary according to the domain in which the system is working, and the objects and relationships will be those that appear in the domain specification.

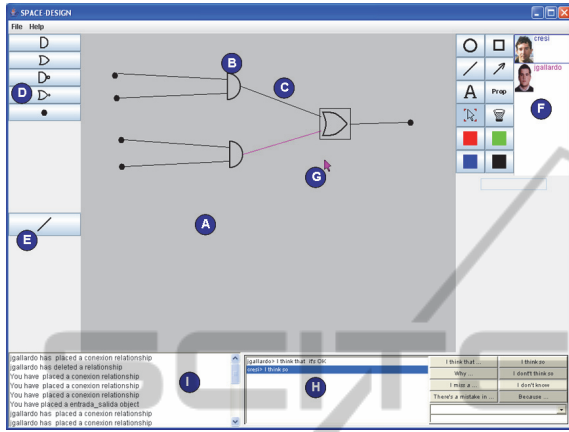


Figure 1: The SPACE-DESIGN tool working with the domain of digital circuits.

An important characteristic of SPACE-DESIGN are the elements for awareness (Dourish and Bellotti, 1992) and collaboration support that are included by default. These elements are: a session panel that shows the users who is participating in the design session and identifies them by means of a specific color (F), the identification of the elements that users select by means of colors, the telepointers that indicate where the other users are pointing to (G), a structured chat feature for communication between the participants (H), and a list of interactions indicating what actions have taken place and who has carried them out (I).

The presence of these awareness and collaboration support elements is one of the features that make SPACE-DESIGN different from other similar systems, such as Synergo or CoolModes. However, the main differences between SPACE-DESIGN and these systems are that, while the former adapts itself in a flexible way to new domains, incorporates awareness mechanisms, and stores the developed models in XML files (Figure 2), the other systems have difficulty incorporating new domains, have fewer awareness mechanisms and, in the case of CoolModes, store the models in a proprietary format (Gallardo et al., 2008).

Concerning the supported domains, the aforementioned systems allow for the modeling of several domains from a series of specifications programmed in the system itself, whereas SPACE-

DESIGN defines the domains in a way that is external to the system, by means of specifications that can be built by end users. This means that any domain made up of objects and relationships between them, and actions to manipulate them can be modeled in this way, and as such, SPACE-DESIGN can be used to work with this domain in a collaborative way. Specifically, in this work, starting from the use cases domain specification, SPACE-DESIGN adapts its user interface to give support to use case diagram modeling.

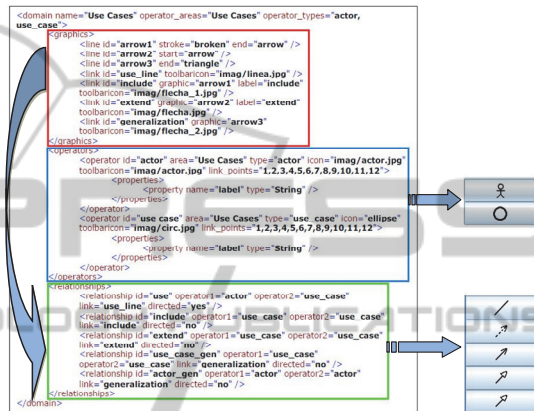


Figure 2: Excerpt from the specification of the use cases domain and its translation to the user interface.

SPACE-DESIGN has already been tested with domains such as digital circuits, conceptual maps, Bayesian networks, etc. (Duque et al., 2008). Regarding the work described in this paper, this differs from previous ones on this tool in the application domain chosen, in the fact that we have carried out an empirical study, not just a heuristic analysis, and in the focus on the analysis of communication mechanisms.

Next, we are going to detail the possibilities of communication (that is, the communication mechanisms) that SPACE-DESIGN is provided with.

3.1 Communication Features of SPACE-DESIGN

As stated before, communication is a very important issue when performing collaborative tasks, especially in real time working environments; the most usual communication mechanism is the exchange of textual messages. SPACE-DESIGN supports three types of synchronous textual communication as follows:

- **Free Communication.** With this name, we are

referring to the kind of communication that happens in traditional chats. That is, communication that is based on the free exchange of textual messages among the members of the work team. No constraints are defined in this sense.

- Communication with References to Objects.** Regarding collaborative modeling, in addition to traditional free talk, it is possible to enrich the conversation with some references to the domain objects in the collaborative task in which the work is being done. The different domain objects (actors and use cases in the domain of use case diagrams) that can be placed in the shared context can be selected and included in the conversation. It is assumed that including references to domain objects favors group and task awareness, as it allows guiding and centering the conversation on certain elements from the shared model.

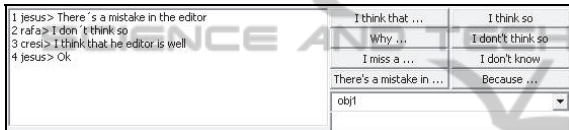


Figure 3: The structured chat with references to objects included in SPACE-DESIGN.

- Structured Chat.** This kind of chat provides users with a set of predefined messages with which the user can show the kind of contribution or message, as well as its intention. Thus, the organization of the talk is favored. The categories of the messages can be defined according to the particular needs of the collaborative task to support and to the specific domain in which work is being done. Moreover, this technique allows reusing structures from previous conversations, as the text of the messages is often a sentence, opinion or comment that is used during the task on a regular basis. In the case of SPACE-DESIGN, messages have been classified regarding their *type* (statement, question or answer) and their *position in the conversation* (some of them are conversation starters, such as “Why...” and others are reactive ones, such as “Because...”). Table 1 depicts the generic sentence openers in SPACE-DESIGN. In this kind of chat, references to objects are also possible. In fact, SPACE-DESIGN offers the possibility to have a structured chat with references to objects, as is shown in Figure 3.

Table 1: Sentence openers in SPACE-DESIGN.

Sentence opener	Type	Position in the conversation
I think that...	Statement	Conversation starter
Why...	Question	Conversation starter
I miss a...	Statement	Conversation starter
There's a mistake in...	Statement	Conversation starter
I think so	Statement	Reactive
I don't think so	Statement	Reactive
I don't know	Answer	Reactive
Because...	Answer	Reactive

4 EMPIRICAL STUDY

In this section, we describe in depth the empirical study carried out to evaluate the different possibilities of synchronous communication that SPACE-DESIGN is provided with. We have considered it interesting to analyze how users collaborate using the different communication mechanisms, and how such mechanisms have an influence on the work performed and the results obtained. In this sense, we have tested the three kinds of chat in SPACE-DESIGN. We have tried to state whether there is an influence of the kind of chat on the work carried out. In addition, we have an interest in knowing the subjective perception users have regarding the *usefulness* of the mechanisms, as well as their *preference* for one or another kind of communication. Regarding communication issues, we have also asked users for their preference between the three kinds of chats.

Thus, the research questions we contemplate in this scenario are the following:

- Does the choice of a certain communication mechanism have an influence on the fluency of the communication?
- Does the communication mechanism have an influence on coordination?
- What relationship between the communication mechanism and the quality of the use cases models exists?

4.1 Participants

A total number of 28 students of the *Escuela Superior de Informática* in the University of Castilla-La Mancha (Spain) took part in the study voluntarily. All of them were taking a course on Software Engineering in the third year of a Computer Science degree.

4.2 Experimental Task

The collaborative task to be carried out by the participants consisted in building a use case diagram making use of the SPACE-DESIGN collaborative tool. Students were given a textual specification of the problem to be solved, which was of an intermediate difficulty. Two different problems were proposed, so not all the groups solved the same problem. Specifically, the problems were: (P1) the modeling of the system of a tour operator that had to manage trips and travelers, and (P2) the modeling of the system of a harbor, which had to deal with the management of ships, the arrival of boats, etc. Figure 4 shows a screenshot obtained during the study. In the figure, the work done by a group of participants that had to solve P2 can be seen. The screenshot corresponds to a user who is not editing the diagram. The tele-pointer of the user who is editing can be partially seen in the bottom of the diagram. The last messages exchanged by the users can be seen in the chat.

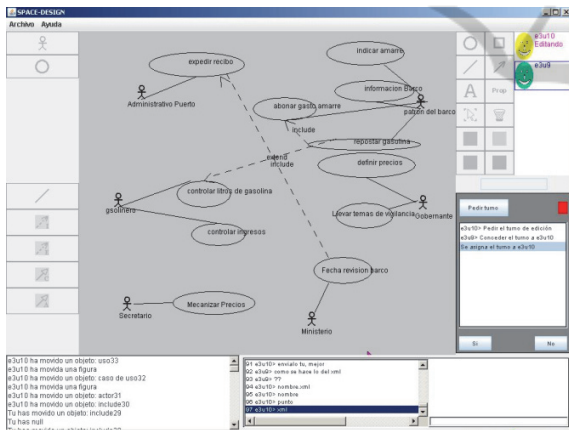


Figure 4: Screenshot of the use of SPACE-DESIGN during the empirical study.

4.3 Experimental Design

For the design of this empirical study, several steps were followed. Firstly, the students who were to take part in it attended a seminar about the SPACE-DESIGN tool. There, students could try out the tool and learn how it works, which features it includes and what it can be used for.

Then, the 28 participants were divided into two groups of 10 members and one group of 8 members. Two groups worked on problem P1, whereas the remaining group worked on problem P2. Participants in each group were then grouped in pairs whose participants were physically separated while

carrying out the study. Each group was randomly assigned a different communication mechanism. Thus, 4 pairs (8 participants) used the traditional chat, 5 pairs (10 participants) used the chat with references to objects, and 5 pairs (10 participants) used the structured chat.

During the problem solving, in which the modeling task was carried out, participants were allowed to look up the help manual of the tool, as well as the formulation of the problem to be solved. Each participant was provided with a unique user name and password so that they could use the tool and access the work session they should join. The structure of sessions and groups is depicted in Table 2.

Table 2: Structure of sessions and groups in the empirical study.

Problem	Chat	Participants	Groups
P1	Chat with reference to objects	10	2
	Traditional chat		1
	Structured chat		2
P2	Chat with reference to objects	8	1
	Traditional chat		2
	Structured chat		1
P1	Chat with reference to objects	10	2
	Traditional chat		1
	Structured chat		2

Once the task was completed, the participants in the study went to fill out a test made up of 10 questions with a five-point Likert scale format. This test allowed users to evaluate the usefulness of the tools, as well as of the different communication mechanisms included in it. The test also included a section for additional remarks, in which participants could express their opinion or make suggestions for the improvement of the tool and the study.

This empirical testing was designed with the aim to lighten some threats to internal and external validity. For example, each group was randomly assigned a different communication mechanism. In addition, the universe of discourse of the problem to be solved was well known by the participants. Regarding fatigue effects, the average time spent in completing the designing tasks was approximately 60 minutes. Hence, we consider that fatigue did not have an influence on the result obtained. In relation to subject motivation, we have to mention that subjects were highly committed to this research. In relation to external validity, one issue that could affect the validity of the conclusions of this study is the size of the sample data. We are aware of this, so

we will consider carrying out replications of this study with a larger sample size. Other issue to analyze is the sample nature. In order to guarantee the external validation of empirical studies, it is recommendable to recruit representative participants. Because of the difficulty of obtaining professional subjects, we used undergraduate students from a software engineering course. This fact threatens the validity of conclusions and external validity. However, if we consider that students can be considered future professionals and had enough capacity to participate in this task, these experimental subjects can be considered appropriate.

4.4 Results and Discussion

In this section, we are going to show the results of the empirical study, discuss them and state the conclusions that have been drawn from them. We have divided this discussion into three subsections: the first one is about a descriptive analysis of the data collected, in the second one, we study the possible correlations between the data, and in the third one, we deal with the results of the subjective opinion of the participants about their experience.

4.4.1 Descriptive Analysis

We are going to start by talking about the metrics we have calculated for the groups taking part in the study. Firstly, we are going to consider the *amount of information* exchanged by the groups, which we have measured by means of the *number of messages* exchanged, the *average number of words per message* and the *total number of words exchanged*. In these three metrics, when grouping the values considering the kind of chat, the chat with references to objects obtained better values (Table 3).

In addition to this analysis of the amount of information exchanged, we have also analyzed the content of the messages and their nature. From these data, we calculated the *number and percentage of interrogative messages* as well as the *number of domain dependent words exchanged* between the members of the group (see Table 3). We classify domain dependent words as those that refer to use case diagrams (“use”, “case”, “actor”, “extends”, etc.) as well as those which are specific to the problem formulation. Examples of relevant words are “room” or “lodging” in P1 and “boat” or “dock” in P2 (actually, the words in Spanish with those meanings). In this sense, the values were again higher when calculating the totals and averages for the chat with references to objects. Thus, we can state that the communication was more fluent in the

groups working with that kind of chat.

Table 3: Statistics on messages and words communicated during the study. Each cell includes the mean value (M) and, in parentheses, the standard deviation (SD).

	Traditional chat	Chat with references to objects	Structured chat
Total number of messages per group	104.25 (45.26)	151.40 (48.86)	98.60 (48.94)
Average number of words per message	5.10 (0.91)	5.98 (1.33)	5.06 (0.55)
Total number of words	61.25 (33.89)	106.00 (24.38)	70.40 (46.26)
Number of interrogative messages	16.50 (13.08)	24.40 (5.46)	12.60 (6.88)
Percentage of interrogative messages	14.39 (6.93)	18.72 (11.24)	12.73 (5.12)
Number of domain dependent words	51.25 (31.08)	76.60 (20.68)	53.60 (38.89)

Regarding *coordination needs*, we measured the *number of turn changes* accomplished by each group. Groups using the traditional chat obtained higher values ($M=7.25$; $SD=2.06$), whereas groups with the chat with references to objects received smaller values ($M=5.80$; $SD=1.92$).

Taking into account all the data collected up to this point, we can conclude that the possibility of including references to domain objects seems to cause the users to focus on the conversation and make longer contributions, which are centered on the problem to be solved. In addition, it seems that with this chat it is less necessary to move the conversation between the members of the group. At the very least, we have detected fewer turn changes than in other cases.

Next, we are going to match these results with the *performance* of the groups when solving the modeling problem. The teacher evaluated the models developed during the study by giving each one a grade on the solution given to the problem. The grade was later divided into two separate grades regarding *use cases* and *relationships*. All these grades were calculated with 0 as the lowest and 10 the highest value. In this sense, again those that made use of the chat with references to objects obtained better grades ($M=6.21$; $SD=1.35$), whereas those who used the structured chat obtained the worst ones ($M=4.31$; $SD=2.21$). To check whether these results were influenced by the previous

knowledge of the participants, their teacher was asked about the *previous grades* they had obtained in the course. Taking all of this into account, it was discovered that some groups were made up by students with similar previous grades (*homogeneous groups*), whereas some other groups consisted of two students with significant differences in their previous grades (*heterogeneous groups*). As we did not intentionally arrange the groups in this way, it is difficult to draw definitive conclusions about how this difference affected the other variables being analyzed. Thus, in future studies we will study the influence of the distribution in homogeneous and heterogeneous groups on the performance.

4.4.2 Correlation Analysis

In addition to the descriptive analysis of the data collected, we also carried out a correlation analysis between the variables. Next, we are going to discuss the main correlations that appeared. The first correlation we detected was that those groups whose members had higher previous grades used more domain dependent words when using the chat ($r=0.60$; $p=0.05$). It can be deduced from this correlation that those groups whose members performed better in the course were more focused on carrying out the activity. In addition, these groups were those that exchanged a higher number of messages ($r=0.64$; $p=0.05$). The correlation with the number of interrogative messages was also positive ($r=0.69$; $p=0.05$).

On the other hand, a negative correlation ($r=-0.57$; $p=0.05$) was detected between the number of turn changes and the number of exchanged words. This makes us think of two styles of working between the members of the group: a style in which one of the two members is working most of the time and the collaboration is made by means of the chat, and a second style in which members make less use of the chat and prefer to frequently change turns.

Lastly, it is worth noting a correlation that is not related to communication issues, but is specific to the domain of use case diagrams. Specifically, a positive correlation between the size of the model and the grade given by the teacher to the model regarding the suitability of the use cases chosen was detected ($r=0.69$; $p=0.05$). From this correlation, we can infer that, in those cases in which users did not select the proper set of use cases, the usual situation was that they used fewer use cases than the amount included in the solution of the problem, and not the inverse situation in which they had used too many use cases.

4.4.3 Subjective Opinion Analysis

To finish with the analysis of the study, we are going to talk about the results related to the *subjective perception* of the participants concerning the use of the tool and its communication mechanisms. In order to collect the information, participants filled out a test made up of some questions with a Likert scale (1 to 5). Some questions were meant to find out the opinion of the participants about the *usefulness* of SPACE-DESIGN for the collaborative modeling of use case diagrams. Participants gave a mean value of 3.6 ($SD=0.4$) to that variable. This led us to think that users expressed their interest for the use of a collaborative tool such as SPACE-DESIGN for the collaborative design of use case diagrams. Thus, we could state that users would choose SPACE-DESIGN or a similar tool when willing to carry out such collaborative tasks instead of using single user tools shared by means of any software mechanism. This is a preference we have found in previous works (Gallardo et al., 2011).

In addition, the test contained some questions about the *preference* of the participants on the different communication mechanisms. In this sense, most users preferred the traditional chat, being the chat with references to objects the second one most valued and the structured chat the one which was least valued by the participants. However, in the case of these two kinds of chat, the possibility of referring domain objects during the conversations was given high values ($M=3.4$; $SD=0.34$).

5 CONCLUSIONS AND FUTURE WORK

In this paper, we have started by introducing a synchronous collaborative tool that can be specialized to work with several modeling domains. In this case, we have specialized the tool to make it work with use case diagrams, and we have used it to do an empirical study so that we can draw some conclusions about how users carry out collaborative tasks and how communication during the work sessions has an influence on the process and the results of the work.

The study carried out is preliminary, and will be followed by some other studies with more users and tasks that are more complex. Nevertheless, we have drawn some interesting initial conclusions about the variables being studied. For example, regarding communication issues and previous grades of the participants, we have observed how users with a

higher knowledge level have communicated to each other more. Specifically, they have also exchanged more domain specific messages, so they have focused more on the task to perform. In the same way, it has been possible to identify a difference between two potential styles of collaborative work: one in which collaboration occurs at a communication level, and another in which there are frequent turn changes. Regarding domain specific conclusions, the most relevant one was that when users had problems defining the suitable set of use cases, these problems came from a lack of use cases, and not an excess of them.

Another conclusion we have drawn is that users do not find different versions of *advanced* chats we have implemented useful. Instead, they prefer to use the traditional chat. This can be seen in the statistics of use of the chats as well as in the subjective evaluation carried out by users. Regarding statistics obtained during the study, users working with the chat with references to objects exchanged more messages, changed turns less often and obtained higher grades. We have concluded that users working with this chat seem to focus on the conversation about the problem to be solved. However, a traditional chat do not cause this effect and causes users to change turns very often. Concerning recommendations for the further use of chats in this kind of tools, the study make us think that the traditional chat is the best option as long as the advanced chats do not include features that make them attractive enough for users. A better ease of use or some adaptable options may help to achieve this goal.

To conclude with, it will be necessary in further empirical studies to analyze the reasons behind the preference for the traditional chat. The uselessness of advanced chats for a certain domain and an incorrect implementation of the concepts incorporated in the tool are some possible reasons that will have to be considered. For example, a different set of sentence openers in the structured chat may have yielded higher values. In general, results obtained during the study may have been influenced by the amount of users that participated and for the nature of the problems that users solved. Thus, in further studies we will try to count on the presence of a higher number and more representative sample of users and we will use a different kind of problems in order to check whether the results of this study are validated or not.

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