Analysing Interaction in a Collaborative Game: a Case Study

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Abstract

This work aims the investigation of the interaction which takes place among participants of a learning activity using a collaborative synchronous simulation game. This collaborative system was designed to help the process of manufacturing concepts learning. A conceptual framework is proposed to be used in analyses of interaction. We used this conceptual framework to study: the nature of the speech acts taking place during the activity, the role of players and the speeches and conversations characteristics.

Keywords: CSCL, interaction, evaluation

1. Introduction

In the past few years some computationally-based systems were developed to support synchronous and asynchronous communication between individuals and groups. Examples include systems for Distance Education, Collaborative Work and entertainment.

In many chat spaces, conversations are ephemeral, lasting only while the current session is alive. At workplaces, informal conversations enable specific information exchanges and are as important as the formal procedures to their jobs. Most computer-supported environments for distance learning, as well as environments for group work, include some tools to support conversation among individuals. Despite the fact that these applications allow conversations to be recorded, analysis of the interaction in these environments are seldom reported in literature. This work aims to investigate the interaction which takes place among participants of a learning activity using a collaborative synchronous simulation game.

Interaction within a group can be understood in its wider meaning as an articulation of relationships of reciprocal influences among individuals; each individual is under the action or influence of others and, at the same time, s/he has the possibility of acting or influencing others (Antillanca and Fuller, 1999). Thus, interaction among users of a collaborative system is a sequence of influenced actions; the first one initiated by the action of a user that influences other users, followed by the reciprocal actions initiated by the influenced users, and so on. In collaborative systems, the influence actions must be somehow coordinated in order to provide users with interaction protocols useful to reach the objectives of the group. In this work we analyse the influence and coordination of the actions by analysing interaction mediated by a shared artefact: a collaborative game.

Collaborators construct and maintain common ground through a process known as *grounding* (Flor, 1998). Common ground is a concept used to explain conversation, meaning mutual knowledge, beliefs and assumptions between two or more people. It is necessary to maintain conversational activity. *Grounding* includes the entire process of conversation turn taking the speakers need to detect and correct misunderstanding. Flor argues that "the notion of grounding provides a conceptual framework for understanding joint interactions between co-workers in a variety of collaborative situations" (p. 202).

While there is a sound theory around the grounding mechanisms that explains conversation, this concept could be extended to collaborations that require the construction of a kind of common ground. This work proposes a conceptual framework for understanding how and when workers interact mediated by a collaborative computer game designed to address concepts of manufacturing processes.

Guerrero et al. (2000) presented a software tool which enabled them to evaluate cooperation. They gathered information concerning collaborative work in a computer-based activity by identifying some cooperation indicators. They identified categories, giving us important insights into the interaction process embedded in group work. But it was needed to develop this classification to encompass the context of a collaborative game with learning objectives in a real usage situation.

The paper is organised as follows: Section 2 presents the working scenario: the context of a factory in which some workers are collaborating through the Factory Game - a collaborative synchronous simulation game designed for a context of learning manufacturing concepts. Section 3 describes the case study: its methodology, the proposed framework, and preliminary analysis of interaction among co-workers in running the game. Section 4 discusses results and conclusions.

2. Background Working Scenario

The scenario for this work is an automotive manufacturing company that was enrolled in a joint project towards the design of computer-based learning environments for the context of the factory.

Nowadays, the most important element of an organisation is the human resources. History shows, however, that it was not always this way. The “mass production” philosophy, which was predominant in the USA in the twenties, had its focus on quantity, on economies of scale and on sales (Mazzone, 1993). The power of decision-making processes were concentrated at the top of hierarchy, while the production line workers followed work routines defined by an expert.

The “lean production” philosophy, created by Deming (1992), in the late 1940s, argues that the focus on the quality in an organised industrial system not only support, but also enhance productivity. The set of new techniques and strategies used to enhance quality and productivity changed the focus from the end product itself to the quality of the manufacturing process. Another important change is on the role of the worker in a lean system, which is not a part of the gears of mass production anymore, but a collaborative person who needs to strive to enhance quality in the production process.

The organisation we are working with is a multinational manufacturer of automotive components. It presents the first signs of a culture tending to the lean production. The distribution of decision-power among the personnel, the incentive to teamwork and a more dynamic role for the shop floor workers are the most important characteristics of the lean production. Together, these ideas propose that solutions to problems in the factory routine should be created by people that are closer to the problems. They also propose that the work in the organisation must be more collaborative and that the operators should be more dynamic and multifunctional in the workgroup (Womack et al 1990). The methodology and the computer game usage through which we conducted the investigation in this work is in accordance with the challenges imposed by the lean production paradigm in manufacturing organisations.

The Factory Game (Baranauskas et al., 2000) is a computer-based learning environment in which users from different places, even different factories can work together to simulate the production process of a hypothetical factory. It was based in a table version of the game, which the company used in past training programs. The tool was built in a process that includes users participation during all development process. Each cell in the simulated production line can be controlled by one player or by the software (if there are not enough players to control all cells). The cells have places for the raw and the processed material. So, the players can produce or transfer processed material to the next cell. The amount of production for each cell at each turn is defined by general settings that varies varying based on a random factor (intending to simulate the machine operation). Figure 1 illustrates a snapshot of the Factory Game interface.

The game allows the definition of some parameters for the production line such as machine variaton range, which represents the cells' production; the number of working days; the total production goal (which could be calculated by the system based on the parameters described before); the Kanban size; the amount of material in each cell at the beginning of the game; the selection between pull or push production systems, etc. . There is a coordinator that is a special player and is responsible for setting up these parameters and starting a new play. The coordinator is also the player who defines the start of each production cycle. All of the players share simultaneously a common view of the game setting to detect the moves and actions of each other. This requirement is accomplished with a client-server architecture for the software. The common view of the game environment is maintained using a communication protocol that makes the flow of information between the computers possible. To allow communication between players, there is a "chat line" in the centre of the Factory Game interface, through which the users can talk to each other based on directed (exclusive to a player) or non directed messages (to all group). The information flow uses the same protocol described before.

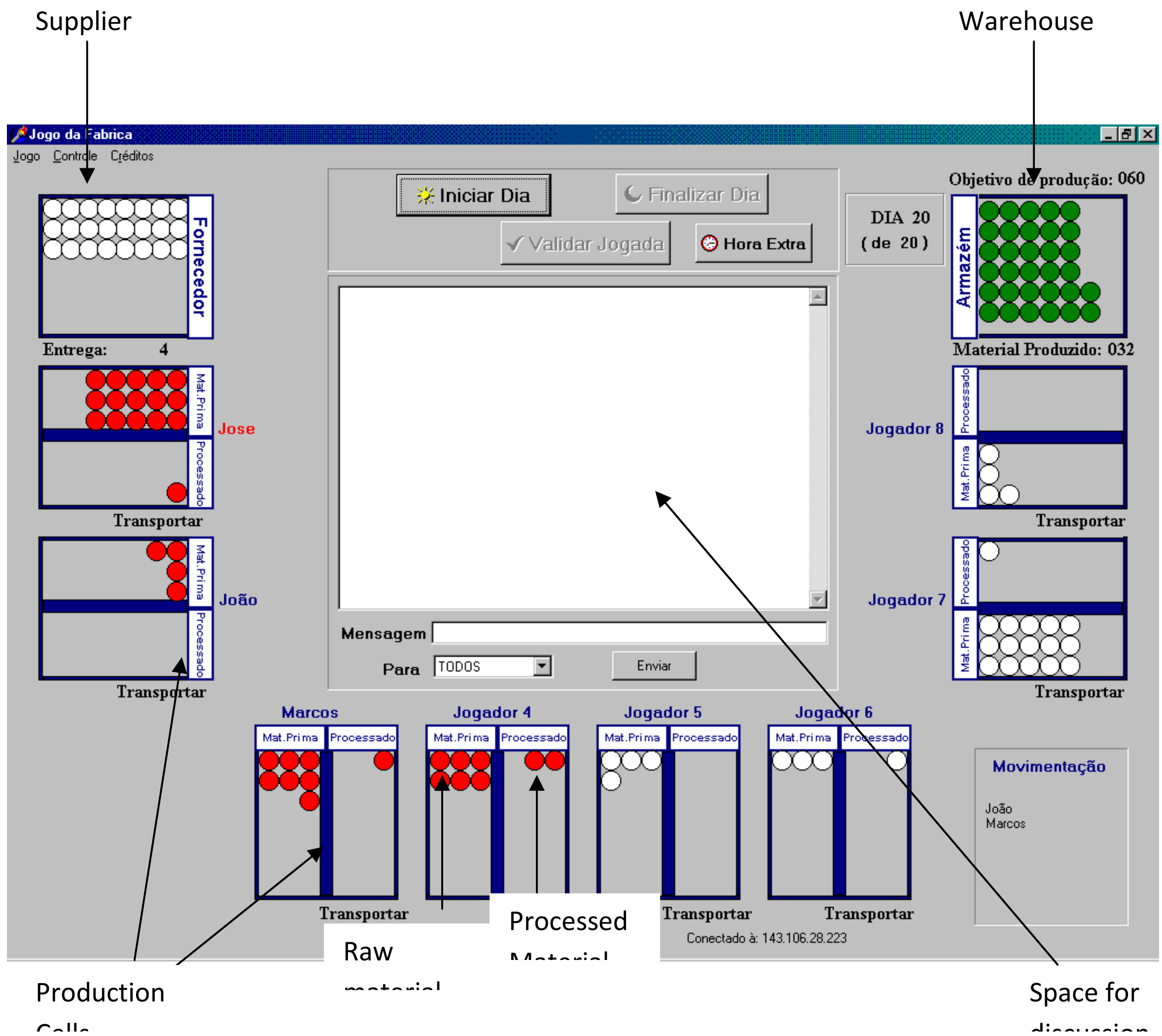

Figure 1. A snapshot of the Factory Game

3. A Case Study of Interaction in a Computer-Mediated Group Work

This study was conducted during the training process of the workers who would be in charge of coordinating the game usage with their colleagues. These workers are called “multipliers”.

In order to prepare the multipliers to use the Factory Game in the company’s formal training program, two hour sessions during five days were conducted. Each session was video recorded and the contents of the chat tool were saved too. The log of three chat sessions are being used in this analysis, one of them having one of the authors in the role of a coordinator and the others, having three prospecting multipliers, including in the coordination activities.

This work presents a first analysis of the interaction and collaboration among these Factory Game users. One of the goals was to identify system characteristics that could make collaboration among users more effective.

3.1 A framework for classifying speeches and conversations

The term “speech” is used to denominate each individual chat message sent by a user or by the system itself. These speeches are classified in different categories identifying:

- • The speaker;
- • The listener;
- • The type of information carried on.

The aims of evaluating the speakers and listeners are to analyse the difference in the role of coordination and the other roles in the game. The type of interaction and needs during the game are obviously distinct to these two different categories of users.

A message could be directed to a specific player or to all players. Frequently some messages were sent to all players, but the context indicated that the speakers intended to send them specifically to someone. This type of message was classified in this paper as a directed message, or, in other words, we considered the intended receiver and not the software defined receiver. This kind of message was not sent because the users did not know how to use the tool. It was reported that they intended to make possible for everyone to participate in the discussions.

Inspired on the classification for the type of information present in the messages of Guerrero et al. (2000), we extended and defined an specialisation of the proposed categories so that it could be used in the Factory Game context.

The users speeches were grouped into three classes, according to the type of information carried out:

- Strategic: the message carries results of a game and their causes. It can discuss also how a good result could be reached;
- Coordination: the message carries help with the system manipulation and the players synchronisation;
- Side talk: the message is not related to the game subject or its results.

These three classes were distributed into thirteen subclasses for a more detailed analysis. To each of these subclasses we associated a two-letter symbol to facilitate the visual representation used in the analysis. Table 1 shows this classification.

Based on the previous framework to speeches, we define a “conversation” as a sequence of related speeches. In this analysis, the conversations were classified according to the user who initiated it (identifying if he is the game coordinator or not), the class of most speeches and the size of the conversation (the number or speeches). We have identified conversations occurring at the same time (parallel) and those that subdivides in branch dialogs that continues in parallel.

3.2 Preliminary Results of Analysis

Each speech in the log file was analysed and its class and subclass were identified. The conversations were delimited. After that, we represented the information graphically. In this representation we plot users and the talks; each arrow goes from the speaker to the listener (to whom it was directed). Arrows are labelled with the classification of the speeches. A horizontal line connects arrows of a same conversation.

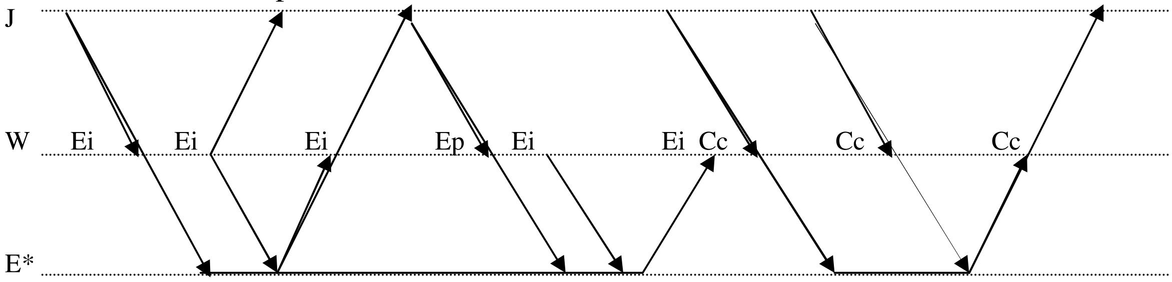

Figure 2: A conversation graphic

Class	Subclass	Symbol	Definition	Example
Strategic	Theory	Et	Discussing and relating theory of manufacturing process to the game issues.	*Kanban is ...* *Kanban, in this game, is represented by...*
	Previous Analysis	Ea	Discussing game settings and the strategy to reach the goals before the starting of the game.	*What can we do to get better results now?* *We can set the parameter ...*
	In course Analysis	Ei	Discussing game settings and relating it to the results during the game. Discussing the strategy to reach the goals.	*Will we reach the goal?* *I think we should give him more overtime now...*
	Post Analysis	Ep	Discussing game settings and relating it to the final results of the game. Discussing the strategy used.	*Why haven't we reached the goal?* *I think we should have given him more overtime in the day...*
	Mixed Analysis	Em	Discussing game settings and the strategy to reach the goals before starting the game, based on the results of a just finished game.	*I think this setting is ok. I wouldn't change it.*
Coordina tion	System help	Ca	Help with the software use.	*To put a piece here you need to drag and drop...*
	Mapping	Cx	Mapping software activities with the related concepts.	*Now we are doing just in time work.*
	Commitment	Cc	Informing actions someone did or will do.	*I'm going to attribute some extra hours to the player ...* *I just did it ...*
	Activity help	Cd	Discussing what should be the next steps in the game. It is not related to	*Now you should put your pieces on the other side.*

			how these steps could be done (Ca), but what could be done based on the defined strategy.	*We can have more discussions using the chat tool.*
Side talk	Contextual	Lc	Discussion that uses the game as context for the speech.	*I'm going to be fired* (he is having bad game results)
	Not contextual	Ld	Discussion not related to the game subject.	*I'm hungry.*
	Social	Ls	Social interactions	*Hello, everybody!*
	Development	La	Discussing the game itself, usually in chats among developers (not the case in this work).	*I think the background colour for chat interface must be blue...*

Table 1: Speech and conversation classification

Figure 2 shows a segment of a conversation graphic for one of the analysed chats. In this example we are not representing the "software speech" (in Factory Game the system itself put some information in the chat space).

Analysing the graphical representation of figure 2, we can identify two conversations, each one with a group of speeches. The first conversation began with J speaker putting an in course analysis speech (Ei) on the chat to the other two players. Then, W answers also to the other two players and the conversation continues. We can also identify that in this case there are not conversations occurring in parallel and the conversations do not have branches. The * identifies the coordinator.

Using the conversation graphic as a basis, we made a qualitative and a quantitative analysis of the speeches and conversations. We aimed at identifying how conversations start and what are the singular characteristics of the larger conversations. This is important because this kind of conversation should give more cognitive opportunities to the users engaged in collaboration.

Tables 2 to 7 summarize some of the results, that will be discussed in the next session. The speeches generated automatically by the software were not taken into consideration in these tables. The position of the software originated speeches in the conversations were used in other analysis, trying to identify if this software message have some interference in the course of the conversations.

3.2.1 Discussion

The results show that conversations usually maintain the same classification of their first speech. There were no conversation in a different class from its first speech in all analysed situations.

Analysing Tables 2 and 3 we could identify that 33% of the conversations are from the strategic category, and 52% of the speeches are also in this class. Usually the strategic conversations are larger than the other categories. We can see it in Table 4: from the conversations with more than ten speeches, 67% are in course analysis (Ei).

Among the strategic classes we had only in course analysis (Ei) conversations. This suggests that the users do not discuss the game settings neither before the game nor after it to analyse results; that would be important in a learning environment.

The coordinators initiated 67% of conversations (Table 5). But in one of the game runnings (chat 1) we observed that all the conversations were initiated by one of the other players. The authors know that s/he had more knowledge about the game concepts and how to play. At this game running, this player naturally played the role that would be expected from the coordinator. We could infer from this analysis that the better prepared the user is, the more he speaks and initiates conversations.

The coordinators began 86% of the coordination conversations (Table 7). This number is 19% bigger than the general coordinators conversations (67% in Table 5). This result suggests that, as would be expected, coordination conversations usually come from coordinators. On the other hand, no side talk conversation was started by the coordinators.

We could identify that coordinators began 67% of the conversations, and 56% of the speeches (Tables 5 and 6). This fact suggests that they usually started the discussion but the other players had a bigger participation after the start.

In the games we have played in the factory plant, speeches and conversations of the side talk class were not expressive, according to Tables 2 and 3. Table 4 shows that every conversation in this category is unitary, i.e., there is no answer to side talk speeches. This result changes drastically in a university context, for example, where we also made observations of people using the Factory Game.

According to Table 4, half of the conversations are unitary ones. In other words, half of the initiated conversations had no return. 61% of these unitary conversations are of coordination category. On the other hand, only 22% of the unitary conversations are from the strategic class, a much smaller number than the 33% general strategic conversation participation in the game running. These results suggest that strategic conversations usually lasts longer than the other types do.

Side Talk	8%	Strategic	33%	Coordination	58%
Lc	100%	Et	0%	Ca	5%
Ld	0%	Ei	100%	Cx	5%
Ls	0%	Ea	0%	Cc	29%
La	0%	Ep	0%	Cd	62%

Table 2: Conversations: general quantitative results (the first line presents the percentage of conversation in each class. The others lines presents the proportion of each subclass in its class)

Side Talk	4%	Strategic	52%	Coordination	44%
Lc	100%	Et	3%	Ca	2%
Ld	0%	Ei	94%	Cx	8%
Ls	0%	Ea	0%	Cc	17%
La	0%	Ep	3%	Cd	73%

Table 3: Speeches: general quantitative results (equal to table 2 format)

#Speeches	All	Side Talk	Lc	Strategic	Ei	Ep	Coordination	Ca	Cx	Cc	Cd
=1	50%	100%	100%	22%	100%	0%	61%	9%	0%	45%	45%
<=2	6%	0%		0%			100%	0%	0%	0%	100%
<=5	22%	0%		50%	100%	0%	50%	0%	0%	25%	75%
<=10	14%	0%		40%	100%	0%	60%	0%	33%	0%	67%
>10	8%	0%		67%	100%	0%	33%	0%	0%	0%	100%

Table 4: Conversations size (number of speeches) evaluation table (the Ld, Ls, La, Et and Ea column subclasses were eliminated because there were no conversations of this subclasses). The first column presents the conversation size. The others columns

presents the size of all conversations, by classes (side talk, strategic and coordination), and the proportion of each subclass in the classes.

Starter	Coordinator	Others
Chat 1	0%	100%
Chat 2	74%	26%
Chat 3	67%	33%
Average	67%	33%

Table 5: Conversations start evaluation table (who did the first speech of each conversation)

Starter	Coordinator	Others
Chat 1	33%	67%
Chat 2	59%	41%
Chat 3	54%	46%
Average	56%	44%

Table 6: Speeches origin evaluation table

Side Talk	0%
Strategic	50%
Coordination	86%

Table 7: Percentage of conversations started by the coordinator grouped by classes

Conclusion

Based on the results of this work, we are now analysing how the system itself could improve the interaction and collaboration among the users. For example, the system could be starting strategic conversations by itself. Some "strategic conversations starters" could be put in the chat tool automatically by the tool during the game running to increase potential discussions. We are also analysing how a system agent could help the coordinator to identify when a strategic conversation could be initiated. We could also detect in the analysed data that there were no previous (expected) or post analysis of the game results, while this kind of analysis would be very important for the conceptual development of the users in the subject. So, we are trying to identify "starters" for this kind of conversation too.

Unlike the public chat tools, the game players did not use frequently the addressee system facilities, even when the message was obviously directed to someone. In the version of Factory Game we used in these analysis, when a player selected the addressee, only this addressee receive the speech. It could be an improvement in the game to enable the choice for messages specifying adressees if it is a private or not private speech (like in the ordinary chat tools). This way, we could direct a message to someone, maintaining the possibilities of answer and discussion with everyone else. This could promote more learning opportunities through the interaction among all the players. Nevertheless we need further investigation to say whether a private talk in learning tools like the Factory Game would be advisable.

Another conclusion, concerns the construction of the conversation graphics and their classification. Although the obtained results encourage this type of analysis, the process of constructing these representations was very time consuming. The authors studied the possibility of using ethnographic tools to help, but they had no success. Now, a tool to help in these analysis is being designed.

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