Experimental Findings with Collaborative Writing within a Project-Based Scenario

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Abstract **- The modeling of the process is a key point for the successful use of collaborative project-based learning environments. We built a cooperation model expressed as patterns in order to point out these ideas. In this paper, we describe the scenario chosen to evaluate the model: collaborative writing projects and EdiTex, a groupware tool to support them. We tested our ideas by using EdiTex in two case studies, with over 30 participants. The results were promising, pointing out the relationship between the process design and the level of collaboration. Moreover, new case studies must be carried on in order to validate our findings.**

Index Terms **– Computer-Supported Collaborative Learning, Collaborative Writing, Case Studies**

I. Introduction

THE definition of activities in a project-based collaborative learning environment is extremely important to determine the positive interdependence required to stimulate collaboration in any context. Teachers and students need flexible environments to support them in the use of the computing technology and to allow the configuration of different scenarios for collaborative projects. Several authors have agreed on these requirements for CSCL [1, 2, 3]. In spite of this, most CSCL environments neither provide mechanisms to the definition of the collaborative process, nor address all stages required in a project-based approach.

We proposed a Cooperation Model for project-based learning, presenting solutions for the definition of educational collaborative processes and their interdependencies with learning theories, cultural aspects and previous knowledge. Our approach was to model the main aspects involved in the collaborative process, designing a cooperation model, expressed as a system of conceptual patterns [4, 5, 7]. From this model, we developed an infrastructure for collaborative project-based learning environments [6].

The scenario chosen to evaluate the model was projects where groups of students had to write documents. Thus, based on our premises, they should define their workflow in order to achieve the objectives and use an appropriate tool to support them in their tasks.

This paper presents EdiTex, an educational groupware for collaborative writing, implemented within this context. Our goal was not only to observe the act of writing collectively, but also to evidence the importance of modeling the process of collaborative writing in order to augment it and, consequently, enhance learning in a CSCL environment. Therefore, we adopted an experimental approach to validate our premises. The design of EdiTex considered our main concerns and incorporated features that helped perform the tasks and evaluate them the afterwards.

In Section 2, we briefly discuss the theoretical basis of project-based learning, which constitutes our work context. Section 3 describes the design and implementation of EdiTex, an educational groupware for collaborative writing. Section 4 presents the results obtained with the use of EdiTex in real educational settings. The conclusions and future works are outlined in Section 5.

II. Project-Based Learning

Project-based learning is not a new educational approach; therefore it is useful for designing CSCL environments. A project is a "wholehearted purposeful activity proceeding in a social environment" [8]. Kilpatrick introduced the Project Method in 1918, when science was moving towards making curriculum relevant to the cultural context of students. The Project Method was designed to solve real-world problems by using a variety of instructional practices, including laboratory work. Rather than creating curriculum based upon the

subjects, the Project Method taught content through discovering solutions to real problems that occur in a humans' life. Educators felt that science class was the ideal place to practice this method because of the advantage of having a laboratory for genuine inquiry activities.

The Project Method was reinforced by Dewey's ideas, for whom, education depended on action [9]. Knowledge and ideas emerged only from a situation in which learners had to draw them out of experiences that were meaningful and important to them. These situations had to occur in a social context, such as a classroom, where students gather and handle materials, creating a community of learners who build their knowledge together.

Learning through projects happens by means of interaction and articulation among distinct knowledge areas. These connections are established starting from the students' daily knowledge, whose expectations, desires and interests are mobilized in the construction of scientific knowledge. The daily knowledge emerges as a result of an external situation under study, therefore without fragmentation into disciplines. It is up to the teacher to provoke the students' mindful of implicit concepts, interviewing at appropriate moments. Some characteristics of project work can be summarized as follows:

a) To consider the students' expectations, potentialities and needs;

b) To create the space where teachers and students have autonomy to develop the process of learning collaboratively, with reciprocal changes, solidarity and responsible freedom;

c) To develop the ability to work in team, to make decisions, to facilitate communication, to formulate and solve problems;

d) To develop the ability to 'learn how to learn', so that each one can reconstruct the knowledge, integrating contents and skills according to his universe of concepts, strategies, faiths and values;

e) To not just incorporate the new technologies to expand the access to the up-to-date information, but mainly to promote a new culture of learning by means of creating environments, which support knowledge construction and communication.

This kind of learning adopts the learn-by-doing approach, in which learning quality is improved when the students are involved in the effective execution of a project. Projects are typically carried out in the context of a group, and they can be developed with CSCL computational support. A project requires a certain time dedicated to planning and management. For George and Leroux [10], a project should be structured in time and partitioned in successive stages, forming an action plan. The careful planning of the activities is necessary to provide the project with a temporary structure. The description of human activities as actions performed through operations help understanding the fundamental role that the planning has in human cognition. Previous experiences advance the possible results of future actions; even so these anticipations should be implemented and adjusted in agreement with the conditions of the real contextualized situation. Therefore, the definition of the activities and their execution flow allows configuring the interaction forms and the products within the development of the project. Besides, it allows the teacher, who is not used to propose collaborative situations, to understand the process and to help the apprentices.

It is necessary to count on teachers' experience to plan the projects and elaborate situations that stimulate the students to work in a collaborative way. Situations should lead the students to consider hypothetical solutions for problems proposed in the project, to discuss them, to ponder them and to arrive to final products with conscience of the process traveled by them to reach their goal. A process describes the group interaction strategy to reach to the final product with the participation and the contribution of everybody. The importance of the transitions from individual to group tasks is observed, the goal is to make clear the performance of each group member. In one moment, the work can be divided in parts; even so each one of them requests the involvement and commitment of everybody, because the whole group should generate ideas for posterior elaboration. Processes that have already been followed can be a good learning reference for the new groups. Therefore, the possibility to reuse, to refine and to work over past processes should be considered as part of the group memory.

Based on our premises for collaborative project-based learning and the specifications given by the cooperation model [4], we proposed a collaborative writing project scenario and implemented a groupware tool to support it.

In the next section we present EdiTex, including its design requirements and development stages.

III. EdiTex: A Groupware to Support the Collaborative Writing in an Educational Scenario

In order to test the effectiveness of modeling the collaborative process, we created a particular project-based learning environment, tailored to collaborative writing activities. Projects involve a process and its stages and tasks that need a support tool. In addition, projects generate specific outcomes. The flow of tasks must provide the maintenance of the state of

cooperation, the sense of responsibility on the group work, the goal awareness in each stage within the whole work and high levels of interaction.

Projects are related to research, and research always starts with a problem proposition in the context of a specific subject. In our particular case, we are proposing a teaching and learning situation that involves a clear goal – to learn collaboratively a given theme in the context of a project. The proposed situation was the collaborative writing of a paper. The teacher previously defines a theme and a problem to be explored. The students define a set of activities in order to carry on the project and achieve the goal. There is not standard process for any kind of project, thus it will depend on the group profile and on the theme. Therefore, the environment must be configured in a flexible way in order to supply the characteristics of any kind of project. Within this context, the CSCL environment must to provide appropriate tool for text editing.

The writing of a collaborative document can be a constructive experience if the members of a group share points of view and knowledge in benefit of the final goal. In this way, collaborative writing is more than representation and organization of ideas; it is a process of building knowledge through the group interactions. During the writing process, the apprentices must to be encouraged to interact and to discuss lively the theme in such way that both the individual and the group learning can be assured. A supplementary benefit is the production of documents "enriched by the collective knowledge", reflecting the participants contributions on the theme. The collaborative writing is a four steps process:

a) Brainstorming – survey of suggestions and ideas of each participant about the theme;

b) Planning and organization of ideas – the suggestions of each participant are stored, classified and organized, serving as data base to posterior phases;

c) Composition – each participant edits a complete text or is responsible for one of its parts, using the database composed in a previous phase;

d) Review – texts edited by each participant are reviewed to the finalization of the document.

Some approaches can be adopted for setting up the Composition and Review phases of the collaborative writing tasks: (i) each one of the participants writes a full version of the text and all of then argue their ideas in order to reach a consensus; (ii) each one of the participants is responsible for writing a part of the document, using the ideas generated for everyone and later on a single text is composed joining the parts; (iii) the full text can be broken up in parts defined by the users, being all constructed at the same time for the whole group. Any form of setting up this task must adopt a politics of notations, commentaries and suggestions, in way of to stimulate the interaction among the participants.

To fulfill the requirements previously described, a collaborative writing tool must provide mechanisms for adding notations and commentaries on the document fragments. All the members must have the possibility to visualize the document for complete. It must also have a mechanism of messages exchange among the participants and a mechanism to support the discussion of ideas on the document. We can observe that many of the available collaborative writing tools are not oriented to educational activities. Many of them do not incorporate mechanisms for notations and commentaries and do not provide effective support for the interaction among the participants. In this sense, see Alliance [12], IRIS [13] and PENCACOLAS [14].

The tool for collaborative writing was designed and implemented considering the problems and solutions related to co-authorship in CSCL environments, identified and described in our system of patterns. A pattern is a format adopted to describe the characteristics of the collaborative writing scenario and the requirements of the tool to support it [18]. A pattern presents a problem, a context and the solutions suggested. EdiTex was specified from the requirements met in two patterns: *Collaborative Writing of Documents Activity* and *Tool for Collaborative Writing*.

A. Pattern Name: Collaborative Writing of Documents Activity

Problem: How can collaborative writing activity be carried out in a learning environment as part of a project development?

Context: Many projects developed within learning environments involve the co-authorship of document as one of work activities. This activity usually occurs within the context of other ones to support the collaborative learning process.

Forces: The definition of the role that the collaborative writing plays can contribute to stimulate the interaction, and the sharing and construction of knowledge. It is necessary to define the rules of interdependence in the accomplishment of the task to guarantee that it will be carried out in a collaborative way.

Solution: The activity must to be described according to following criteria:

a) Objective: the activity aims at co-authoring of a document by a group of students, in such a way that,

at the ending of the activity, the students have acquired knowledge on the document subject. In addition, they must put into practice the interchange of information in order to reach the objective.

b) Roles: the writing task in group can involve some roles: coordinator, writer and publisher.

c) Products: the expected product is a document that can contain texts, figures and graphics.

d) Elements of interdependence: the final product is presented by the group and not in separate parts of each one of its members.

e) Rules of interdependence: each member of the group must be responsible for the document as a whole, being able to edit one or more of its parts individually. All members must contribute with suggestions and commentaries on all parts of the work. Individuals can use personal experience or specific knowledge to enrich the work.

f) Support Tools: collaborative-writing tools must take care of all the described characteristics.

Known uses: Some CSCL environments implement the activity of collaborative writing. In some of them, the collaborative writing is the central activity, and its main goal is the learning of writing texts [12, 13, 14]. In other environments, the collaborative writing is inserted in the context of some tasks to be carried through for the group [15, 16].

B. Patterns Name: Tool for Collaborative Writing

Problem: What are the requirements for the implementation of a collaborative writing tool to support the learning process?

Context: Collaborative writing activity is usually present in project-based learning environments. Therefore, it is necessary to specify the requirements for the tool support in order to carry on the activity.

Forces: The collaborative activities proposed in learning environments have some characteristics that must be supported by computational tools. The requirements definition must conform to them. The requirements for implementation of the tool are related to the description of the task to be supported.

Solution: The solution is a list of requirements that can be implemented through the addition of collaborative writing functionalities. The requirements are related the following questions: Edition, Awareness, Coordination, Interaction and Storage.

a) Edition

The user can edit the document either synchronously or asynchronously. Each user can work independently of the presence of the other group members at the same moment.

The document must be structuralized, or divided in flexible fragments of size and format defined by the group

A member of group that is responsible for its edition must own each document fragment. A mechanism for annotations and commentaries on the document fragments must be available.

b) Awareness

All the members of the group must be able to visualize the complete document.

All the members of the group must be able to get information about a fragment owner.

The members of the group must receive notification from changes made in any part of the document.

c) Coordination of the activity

It must be possible to define roles, with different responsibilities on each fragment of the document.

It must be possible to make roles' interchanges during the execution of the task.

All members must have the same chances to contribute in the activity.

d) Interaction

The members of the group must be able to communicate and interact through mechanisms provided by the tool, such as messages and chat in order to stimulate the discussion of ideas on the document.

It must be possible to register of the discussions.

e) Storage of the document

It must be possible to store versions of the edited document.

The user must save the document when the activity is finished.

The user must be able to access previous versions of the document with the respective annotations.

Known uses: The requirements specified in this pattern had been extracted from the main works in collaborative writing found in literature [12, 13, 14, 17].

EdiTex was implemented concerning the problems and solutions described in the model of cooperation. Its requirements could summarized as:

a) *Edition* - synchronous and asynchronous edition

b) *Division of the document into fragments* – addition of annotations and commentaries

c) *Awareness* – total visualization of the document and list of logged users

d) *Communication* – messages and chats

e) *Storage* - Menu File (Save, Open, Close)

EdiTex Features

Tool features and interfaces agree with the described objective and specification pointed in the previous section. In EdiTex, a text is composed for fragments that can be of any type - paragraphs, phrases, sections, and chapters. The group can define the level of granularity of the fragments. Each fragment has an author (who created it) and an identification number. Commentaries can be associated to each fragment. The main screen of the EdiTex has three areas of text (Figure 1):

a) *Notes*: it represents a notepad, where each user writes commentaries and notations on a specific fragment.

b) *Edition Area*: it corresponds to the place where each user will edit its fragments, before sending it to the group. It works as a private space; therefore the content that is being edited is not visible for the other participants until the author sends it, through the Send command in the Fragment Menu, for the entire group.

c) *All Fragments*: it corresponds to the visualization of the full text. In this area, the fragments are visualized as soon as they are sent, thus, in some moments it is necessary to move the fragments in order to get a coherent text.

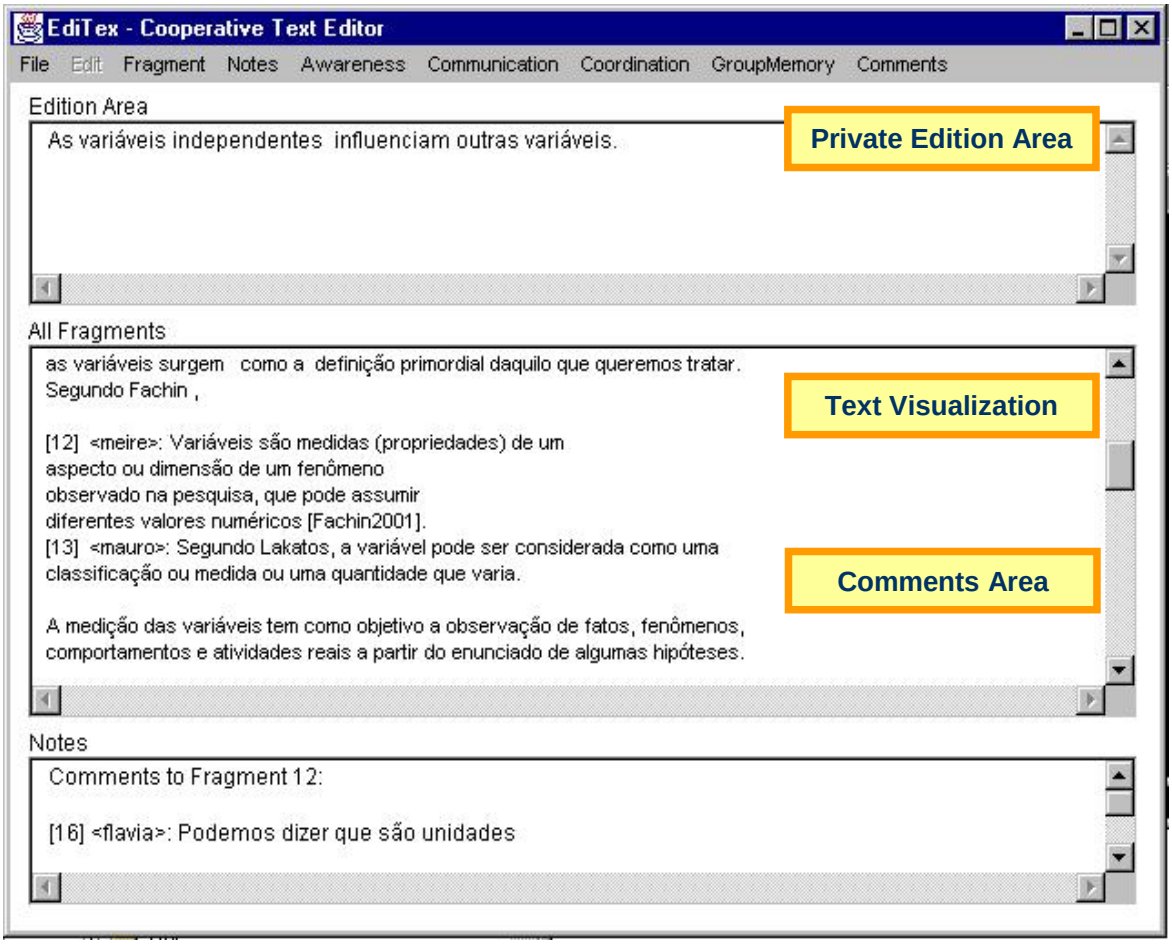

Fig. 1. EdiTex Interface

Following, the tool functionalities and forms of work are detailed.

a) Edition

The user edits a part of the document fragment, using the work area designed for this function. Each user owns parts of the document, which are his entire responsibility, but he must be aware that each fragment will contribute for the final document. Each member can work independently in an asynchronous way, or together with the others in a synchronous way. The window for visualization of the full document is not editable. The user must write commentaries on fragments edited by other users, making suggestions, associated to the fragment that is identified by its number and the name of its author.

b) Awareness

The tool has a List of Users that shows who is logged in determined moment. The mechanism allows users to know with whom they can interact in the collaborative writing task.

c) Interaction

Communication among the users can be made through the chat or the message exchange. In the Chat, talks are stored and put available for visualization, with the option of talking to a specific member or to all the users (Figure 2).

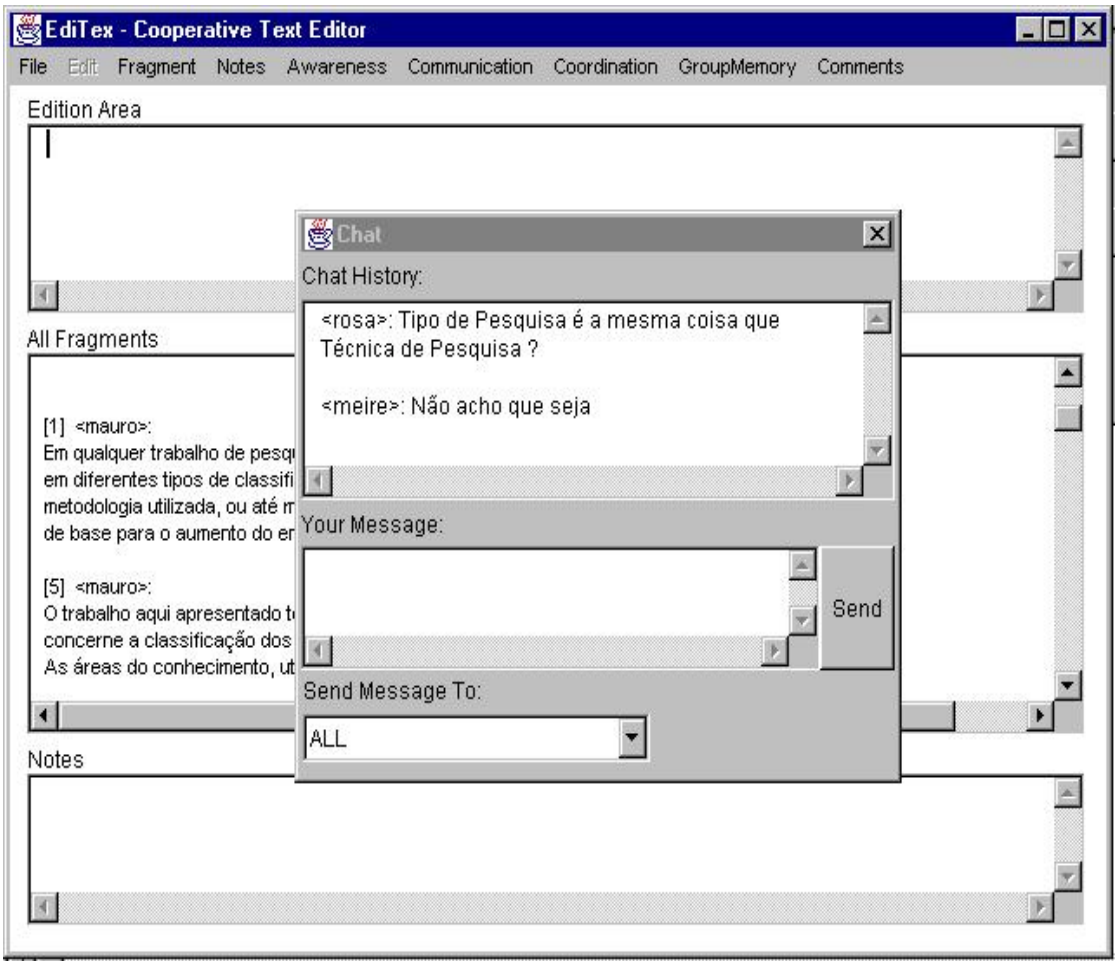

Fig.2. Communication in EdiTex

Design and Implementation

The implementation of EdiTex was made specializing the framework provided by COPSE infrastructure detailed in [5], [11]. The framework is a client server architecture that provides the basic services for communication, cooperation and awareness. The data model handled by it represents the data storage in a document composed of fragments and annotations.

EdiTex: Server Application

The server application role is to manipulate the events that arrive from the client applications, where a session manager is responsible to notify all the users which event was generated. The events handled in the server are *Send Fragment* and *Send Comment.*

EdiTex: Client Application

Each instance of the client application represents a user logged in EdiTex. The client application specializes the client framework in two layers: management and interface. This application controls the presentation of the full document in the area *All*

Fragments, through a FrameInterface class. To update the interface in such way that the user realizes the actions of the other users, it is necessary a mechanism that allows the client layer notifies the interface on the occurred events. The events that are handled in the client are the same events handled in the server.

The tool has three controllers: EditionControl, responsible for the text edition, such as Copy, Cut and Paste; FragmentControl, responsible for the sending of the edited fragments; and CommentControl, responsible for the commentaries on the fragments. The tool manager, using the interface manager, sends the event to be distributed for all the other instances of client application.

IV. Experimental findinds with EdiTex

We wished to evaluate in depth the evolution of the collaborative process within a project development in our CSCL environment and we defined criteria concerned with the several aspects related to this subject. The criteria are summarized in four groups: Communication, Contribution, Coordination and Awareness, which represent the dimensions or increasing levels for the analysis of collaborative process. In the Table 1, we presented a synthesis of the proposed criteria, which were used as metric in our case studies, as a starting point for analysis and comparisons among the processes accomplished by the students in several cases.

Table 1
Criteria and Measure Units

Criteria	Measure Unit
Communication (Interaction and participation)	Number of exchanged messages
	Nature of exchanged messages
Collective Knowledge Building (Contributions)	Number of contributions while constructing a collective product
	Quality of contribution in the construction of a collective product
	Construction/Inference on the contribution of other group members
Coordination (Concentration and organization)	Engagement within a process design
	Performance of the tasks
Awareness	Understanding of tasks and its relationship

1st Case Study

The objective of first case study was to evaluate the influence of a formal process defined to stimulate the collaboration in groups that learn a theme through the development of projects using a CSCL environment support. The motivation for this study relied on a discipline called Groupware Laboratory, offered as complement to the CSCW discipline, in pos-graduation on Computer Science in UFRJ. In this discipline, the project proposed was to write essays about two different themes. Two different situations were proposed: (1st) to accomplish the project without an explicit process defined, and, (2nd) to accomplish the project with an explicit process configured. It means that in the first case, the members of the groups should elaborate their texts in an ad-hoc manner, and, in the second one, the activities, relationship among them and sub-products generated were well defined and known previously by the groups. Our goal was to compare the two situations.

The following variables were defined: Formation of the group (control variable), Proposed situation (control variable), Number of contributions through messages and comments exchange (dependent variable), Quality of contributions (dependent variable), Explicit collaborative process (independent variable), and, CSCL environment (independent variable).

The participants of the 1st study were six Computer Science pos-graduation students, selected by the teacher, which took into consideration the students' formation and experience to try to balance the groups. Two groups of three students worked in two similar projects, unless for the fact that in the first case they did not have a defined process and in the second one they outlined their process and pursued it. In both projects, it was defined a theme and a problem, and the groups should investigate the subject and produce a textual rehearsal based on their discoveries. In the two cases a basic bibliography was given as a starting point to the researches.

In Group 1, some personal communication and relationship problems among the participants have occurred. These problems practically invalidated the possible comparisons between the two experiences. The group tried to specify a planning for its process in the second project; but, as they affirmed in the questionnaire, they did not follow it. Thus, the second project was achieved as a continuation of the first. The students used the collaborative tool to write the second paper, but they did not perform the planned work stages.

In the first project, the Group 2 had a very good degree of interaction, as they own noticed. In its discussions, in spite of many messages without content, it was observed the presence of clear negotiation attempts on some parts of the text. It was also remarked the low level of planning and coordination.

Comparing the results obtained by the second group in the two projects, the participants discerned an increase in the collaboration level. They attributed this result to the explicit process design. Even so, a decreasing number of planning messages is contradictory with it, it could have happened due to the fact that people were already familiarized with

EdiTex, and they have used far more the resources of the tool for discussions (through addition of comments). This shows that people had a feeling of improvement in the interactions and in the understanding of what they should do (the amount of interactions also increased significantly). Many more comments were associated to each part of the writing work, and discussions were generated around these comments, which brought deeper relationships among the individual contributions.

In a normal situation, when the work is not monitored by the teacher and it is not explicit the participation of all the group members, what usually happens is that the group disguises the lack of interaction and presents a well-done work by one (or by just some) of the participants who takes all the responsibilities. With the use of environments of this nature, the possibility of these events to succeed does not, or at least is very hard, to exist, because all the work is very explicit. Yet, the environment is a catalyst that takes the group to a collaboration state. The more a group understands the process it is following, the larger is the collaboration level. Seemingly, the Group 2 demonstrated this theory to be true.

On the other hand, it was observed that the environment is not able to support all the social situations. Group 1's members were not able to communicate with themselves even provided with all the CSCL mechanisms. Like they affirmed, the availability by the people is fundamental, if it does not exist, it will never be possible to configure a collaboration process. The problems experienced by them can be related to the heterogeneous composition of the group, with people from different areas and particularly one of them with low experience in the use of computational tools, and also to the individual, cultural characteristics.

However, an important conclusion can be reached. In the first project, the Group 1 reached to a result, and we can be infer that this happened because this it was much more similar to the traditional molds. From the moment they had to define its interaction forms and the better relationships within the project, it was not possible to go on. In this sense, we can be affirm that the use of the environment addresses the work for a more interactive and explicit form, that is still not usual in our cultural environment.

2nd Case Study

The 2nd case study involved twenty-two students of the discipline Computers and Education, in Pedagogy under-graduation course at Gama Filho University (UGF) in Rio de Janeiro, all of them with low background in Computer Science. One of the works proposed in the context of the discipline was a project, where the students should discuss topics related to the introduction of a program for using computational resources as pedagogical support in schools and write a proposal for it. The experimental approach used here was a comparative case study. The class was divided in six groups, where three would develop the project without a previous planning of the activities, and the other three, with a defined process. In both cases they used EdiTex to support them. For the first three groups the environment was configured to dispose a tool for collaborative edition of texts (named EdiTex), and for the other three, it was configured to dispose a tool for process design, besides the process machine to enact it. Thus, we wished to compare the results of the two types of work in groups.

The basic process used by the last three groups is depicted in Figure 3.

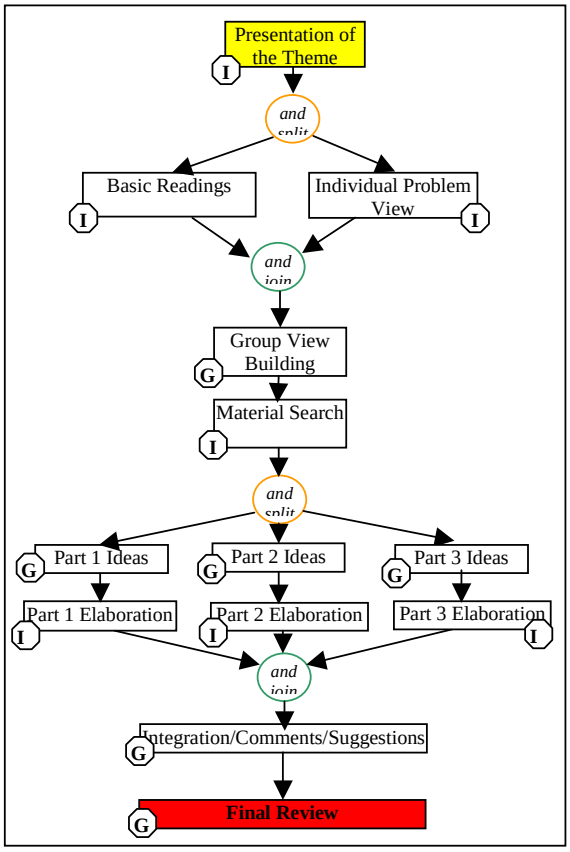

Fig. 3. Process Configuration

The study object was the collaboration degree in the accomplishment of the project. Therefore, the same measure units of the previous studies were observed: formation of the group, proposed situation problem, number of contributions through exchange of messages and comments, quality of the

contributions, collaborative process explicit, and CSCL environment usage.

A low number of messages were exchanged in all group members, due to the fact that they all have communicated basically through the own text, in the shipping of the text fragments. For the generation of the final version, they eliminated the coordination, discussion and negotiation parts. The teacher tracked this implicit exchange of messages within the text, even so it was not reported by the EdiTex. Starting from there, EdiTex allows to extract the indexes (subjective) of relationship among the individual contributions, verifying the commented contributions, the suggestions and modifications done by members of the group to the others people work.

All the groups used the speech as a communication resource. The writing communication induces the elaboration processes for the learning, so they are stimulated within the CSCL environments. Even so, it did not constitute a problem for the study, because all the interactions took place inside of the laboratory and the teacher, which acted also as an observer, could register the most important events manually. For example, in spite of the Group 4 considered to have good a collaborative process, it was noticed that its members were confused in the performing of the tasks, being several times aided by the teacher.

Because they had less experience in the use of the technology, having defined a quite explicit process helped them a lot.

This study indicated that the explicit process design could really stimulate the collaboration in project-based learning environments, because, in general, the groups that defined their work processes had better results in collaboration. Even so, many factors interfere in the results and these cannot be widespread but just applied to similar cases.

One of the interesting aspects observed is that only the fact of using a groupware tool, different from everything they had tried before, was already enough to institute a collaboration state in all the groups. People are accustomed with the group work in traditional manner with division of tasks, and they had to change the way they work. Another observation is the lack of experience in the definition of the work processes and more than that, the inability of evaluating the process was a constant in the groups. Thus, the use of an environment of this type should necessarily go by an adaptation apprenticeship and fittings and the first experiences will be full of uncertainties and lessons to be learned.

General Results

The general results show that the group composition, the task nature, the collaboration context and the infrastructure for communication are key points for successful collaboration in groupware. In all case studies, the tasks performed were similar; all of them involving the collective production of texts, despite the work processes have been different. The groups were composed of people with similar academic formation, and still thus, we observed great differences in work dynamics.

Individual characteristics have strong influence; therefore the environments must to offer conditions of stimulus, as well as to exploit the individualities for the success of the work. Now it is important to carry on our research in order to achieve as far as possible a generalization of the results achieved. A characteristic of the formative evaluation, such as the one used in our work, is that less *authentic* studies, from the point of view of a theory validation, can bring valuable preliminary results. In spite of the limitation in size of the accomplished studies, many problems were discovered and they can be applied in future experiences.

V. CONCLUSIONS

We strongly believe the modeling of the aspects involved in the project-based learning process, such as collaborative writing, is a key point for the successful use of CSCL environments. To test our ideas on the improvement of the collaborative process, we built EdiTex, a groupware application that provides support to processes of collaborative writing. Then, we analyzed the use of EdiTex collaborative capacities in two case studies. We verified that the group composition, the task nature, the cooperation context and the infrastructure for communication are key points for successful cooperation in groupware.

In all the case studies, the tasks had been sufficiently similar; all of them involving the collective production of texts, despite the work processes have been different. The groups had been composed of people with similar academic formation, and still thus, it observed great differences in forms and dynamic of work. Individual characteristics have strong influence; therefore the environments must to offer conditions of stimulus, as well as to exploit the individualities for the success of the work.

The results were very promising, clearly pointing the relationship between the process design and the level of collaboration. The mechanisms implemented proved to address our main goals and configured real situations of developing a project and stimulating collaboration. Future works intend to carry on our research in order to achieve a generalization of the results achieved.

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