Distributed Cognition applied to the empirical analysis of Computer Supported Collaborative Knowledge Management Interactions

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Abstract—In the field of Human Computer Interaction, and more specifically in the field of Computer Supported Collaborative Work and Knowledge Management, cognitive and sociological dimensions cannot be neglected in the design of value analysis. The material and social environment models almost all cognitive processes because the vast majority of them are mediated by the interaction with other agents and other artifacts. Computers connected to the Internet, are becoming fundamental elements of these interactions. Following these premises, in this paper, a methodological framework is applied, called MAIA (Methodology for the analysis of the interaction between agents of a socio-technical system), structured and based on distributed cognition in order to facilitate the analysis of a collaborative Web system oriented to knowledge management in an academic context, at high university level. Specifically, the analysis focuses on the interactions of cognitive agents that occur during the cycle of knowledge management (activities to use, create, distribute and share knowledge), and on how they affect coordination, communication and collaboration, key aspects of group work.

Keywords— Distributed cognition, collaborative work contexts, knowledge management

1. Introduction

This Humans generate a cognitive potential through the creation and active modification of the environment in which cognitive operations are held [1]. Once it is understood that the user interface is a key element of a computer and is part of the cognitive environment, it is then acceptable that this environment presents very relevant cognitive characteristics that will determine the type of activities and social relations mediated and enabled by technology.

Within the field of psychology, the theory of Distributed Cognition (DC) provides a useful framework for describing human systems of work in terms of information and computation, and is viable for the design of technology in the mediating

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collaborative activity. Distributed cognition suggests the idea of sharing information and building knowledge, and there the sense of collaboration and community is underlying. This theory is based on the coordination between individuals and objects, and suggests that human knowledge and cognition are not confined to the individual, but also in distributed memory spaces, in facts, or in the knowledge of the objects in our environment. [7] These aspects of human cognition, inherent to distributed work context, are generally not taken into account when designing and developing digital technologies [7]. Thus the motivation of this work arises, aimed at understanding and explaining the impact of distributed cognition in collaborative activities and knowledge management mediated by a computer. Then, this work focuses on determining how certain aspects of cognition are involved in distributed environments, where people interact and learn with others, with the support of technology. A methodological framework proposed by [2] called MAIA is applied; this framework is structured and based on the theory of distributed cognition, in order to facilitate the analysis of a Web-oriented system focused on knowledge management in an academic context at high university level. Specifically, the analysis from the perspective of distributed cognition focuses on the interactions between the agents identified in the cognitive system, which are originated during the activities of use, creation and distribution of knowledge (knowledge management cycle), and their effects in group coordination, communication and collaboration, which are the key features of collaborative work. The result of this analysis allows for the identification of problems in the interactions of the agents in the cognitive system and to provide sufficient information for the system settings, and in particular for the user interface where interactions occur.

2. Distributed Cognition

The Distributed Cognition (DC) proposed by Hutchins, like the traditional cognitive theory, intends to understand cognitive systems, how they acquire and process information; the difference between the two theories lies in the boundaries of the unit of analysis. The DC aims at analyzing not only those internal cognitive processes of the individual, but also those external processes: socially distributed cognition beyond the subject's mind. [5] Although the term implies something that resides within the person, the idea of distributed cognition extends the meaning of the term to include every person and everything in the environment of the person. In other words, distributed cognition is a system containing the individual, peers, tools, and even their cultural artifacts; and is the relationship between them all that provides the ingredients for knowledge construction, both individually and collectively [10]. The DC focuses on the way in which knowledge is transferred among actors in a system and on how the information required to cooperate is propagated through by representational states and artifacts. Cognitive activities in this context are understood as operations which are performed via the propagation of representational state through media. Media refer here to internal (individual memory) and external representations (computer interfaces, schemas, etc.), while the representational state refers to the way how information resources and knowledge are transformed during activities.

In its most general meaning, the theory of DC talks about the idea of sharing information and building knowledge. It denotes a spirit of collaboration and community (where people interact and learn with others and with the support of technology) in which people are able to build a cognitive system and a shared representation. This illustrates the process of interaction between people and technology, and it is a useful tool for analyzing and explaining the complex interdependencies which take place between people and artifacts in their working activities, mediated by technologies. [3]

According to Hollan, Hutchins and Kirsh, the DC is different from the traditional theory in two theoretical principles. The first has to do with the unit of analysis. In studies of traditional cognition such unit is the individual, while in distributed cognition it is the cognitive activity or task to be performed. The cognitive process is delimited by the functional relationships between the elements that participate in it, rather than by its spatial location (i.e., this process can go beyond the brain of the individual performing the task). The second theoretical principle refers to the range of mechanisms involved in cognitive process. In the traditional view, cognitive events are searched in the manipulation of symbols "inside" of individual actors. [4] In distributed cognition, the search is extended and goes "outside" individuals. Dynamic cognitive systems are then produced, which include both, individuals and the artifacts they use, and the relationships they generate. I.e., cognitive processes are not performed only in the minds of people, but are also distributed in other individuals and in the mediating artifacts used by the group. Thus, distributed cognition extends what is meant by cognitive, when it extends its individual-centered meaning and incorporates the interactions between people, resources and strategies (broadly defined).

3. Description of the Framework analysis based on the Theory of Distributed Cognition

The framework for the proposed analysis is based on the work of [2], in which the utility of distributed cognition is checked together with the validity of the proposed methodology. This framework includes two global stages: **a)** the MAIA application for the analysis and evaluation of a ReSU system (Social Academic Network) oriented to knowledge management in the context of collaborative work for academic training [10]. The analysis focuses in general to the assessment of the ReSU system in the process of knowledge management and the tasks involved (use, create, distribute and share); and, **b)** analysis of the cognitive system units, more specifically, the interactions that occur during the process of knowledge management, the problems that occur in such interactions and the nature thereof, in order to infer the causes and identify the ways to improve artifacts for more effective, flexible and natural interactions.

The framework of analysis with cognitive perspective is oriented to the following tasks: *Display ReSU* as a cognitive system, *assess interactions* between cognitive agents at the knowledge management activities, specifically when knowledge is created, used, shared and distributed, and finally *evaluate the usability* of ReSU.

The case for analysis is described below: ReSU was implemented in a course of the Information Systems curricula, corresponding to the basic training cycle. Students received a theoretical and practical task to be solved in groups. The resolution was supported by ReSU in particular with the provided tools; wiki (for collaborative development of the final technical report) and the forum (as a medium for discussion and consultation during the resolution of the work). The work was a home task and twenty consecutive days were provided for the development; groups of four were organized and to each group a coordinator was assigned, randomly chosen by the teacher. 32 students participated, organized in eight groups of four members each.

3.1 Application of MAIA

MAIA has five stages which are described below.

Stage 1 *Identification of agents*: at this stage agents are selected and analyzed which make up the cognitive system under the ReSU Web analysis. We have identified two types of agents, **structural** and **articulation** agents. In the first type of agents the following have been identified: *Organization, Subjects, Artifacts, Product* and *Environment*. In the second type the agents of articulation *Objectives, Tasks and Activities* are identified.

Stage 2 *Defining the conceptual model:* at this stage the ReSU conceptual model is defined considering each of the cognitive agents identified in stage 1 with a clear knowledge of the relationships between them. ReSU **organization** *sets* a number of **objectives** with the purpose of *generating specific* **products.** In turn, the organization enables individuals accessing from different working environments (laboratory, university, home and cybercafe) and perform their activities and tasks using different artifacts for achieving the stated objective.

Stage 3 Definition *of criteria for analysis:* at this stage the criteria that guide the analysis of the various ReSU components are defined as cognitive system. Based on the identified agents, and the relationships established between them within the cognitive system, aspects of interest for each agent are defined. The purpose of the analysis is to assess issues related to the interactions between agents within the system, in particular the interactions included in collaborative tasks performed by means of forum and wiki and to establish in a certain way the degree of contribution in the construction, distribution and use of knowledge. The raised criteria are related to the subject, artifacts, environment and organization.

Stage 4 *Classification of the collected information*: once the criteria for the analysis were defined in step 3, the collected information is organized in such a way that can be easily interpreted. To do this, a table is constructed with the following columns: *agent*, *factor*, *appearance* and *question*. The first column corresponds to the structural agents identified in step 1. Each of these agents has various aspects that can be analyzed, and these aspects in turn can be broken down into factors. The examination of the aspects is guided by leading questions. Questions regarding the aspects to be analyzed, e.g. roles, participation, artifact appearance, usability, etc., are set out in column four. Table 1 shows the organization of information as per the identified agents, factors and aspects they include and questions for analysis.

Stage 5 *Definition of variables and techniques to collect information*: for each criterion formulated in step 3 and in accordance with the guiding questions defined in step 4, the analysis technique is established and will be used to collect information in each case. The techniques used are questionnaires targeted to the *student* and *teacher* agents (Column five of Table 1). Their responses will allow to obtain data about the effect of the different types of interactions that are running on the ReSU system. The types of variables considered are qualitative and quantitative.

Table 1. Organization of the collected resu information

AGENT	FACTOR	APPEARANCE	QUESTION	TECHNIQUE
SUBJECT	Academic al Status	Academic degree Role Level	P_1. What is she/he studying?	Student questionaire
			P_2. What is her/his role?	
			P_3. What career level ishe/she pursuing?	
	Tasks of coordina-tion of the Knowle-dge	Behavior individually in relation to	P_4. What tasks each student agent performs?	Student questionnaire
			P_5. What is the level of participation (number) of each student on the tasks performed?	Student questionnaire
		Communication Collaboration management	P_6. What is the extent of the interactions between individuals in the system (students and teachers)?	Student questionnaire
			P_7. What is the level of complexity of the cognitive operations of the subject when performing the tasks? P_8. What is the impact on individual performance?	Student questionnaire
		group behavior regarding the communication	P_9. Do the ReSU use and its applications contribute to group production and academic dissemination? P_{10}. Do the use of Resu platforms and web 2.0 technologies improve the quality of academic output?	Questionaire for theacher
		Collaboration Coordination	P_{11}. What is the level of group performance? Is group performance improving?	Questionaire for theacher
ARTIFACT	Usability	Appearance	P_{12}. What is the influence of the Wiki and Forum cognitive system artifacts on the interactions between subjects?	Student questionnaire
			P_{13}. Are the interaction mechanisms provided by ReSU artifacts adequate, and is the interface friendly and intuitive?	Student questionnaire
		Ease of use	P_{14}. Do the students have prior knowledge of the use of Wiki and Forum? P_{15}. Are the Forum and Wiki artifacts easy to use?	Student questionnaire
		Satisfaction	P_{16}. What is the level of satisfaction of individuals in relation to the use of the ReSU system and specifically of Wiki and Forum?	Student questionnaire
	Utility	Efficiency	P_{17}. Do artifacts facilitate the construction, distribution and use of knowledge?	Questionaire for theacher
		Individual Performance	P_{18}. What effect has the ReSU applications on the process of student learning?	Questionaire for theacher
ENVIRO-NMENT	Capacity	Comfort	P_{19}. In what work environment is the subject placed to perform the proposed activities?	Student questionnaire
		Connectivity	P_{20}. Does the environment present the necessary and sufficient features to perform the tasks involved in the cognitive system?	Student questionnaire
ORGANI-ZATION	Accepta-bility	Satisfaction And Acceptance of the work mode	P_{21}. What are the subject's perceptions of the procedures for communication, coordination and collaboration established in the system? P_{22}. Satisfaction in relation to the mode of b-learning work.	Student questionnaire

After completion of the five stages of the methodology, questionnaires are elaborated to be delivered to students and teachers, once home work is completed. Each questionnaire was developed taking into account the guiding questions in Table 1. Some questions have been included in the questionnaire without any modification, and others, have been broken down or adapted according to analysis requirements. The aim of this feedback is to determine if the strategies implemented are adequate to promote the communication and exchange of academic knowledge between subjects, i.e., if the supported cognitive distribution is fostered by the system. Knowing these

aspects will allow us to understand whether the benefits and the extent of resources offered by ReSU are adequate for the cognitive distribution among the agents of the cognitive system.
The questionnaire for the *student* agent aims to analyze the perception they have of their own *interactions* with peers, teachers and artifacts. Also to analyze the perception of the benefit of using technologies in the training process and to consider the facilities they offer for communication, academic exchange, accessibility to contents and resources. The questionnaire for the *teacher* agent aims to analyze whether the use of the ReSU application in the academic environment together with the b-learning mode contributes to the educational process, particularly to student learning. Both, students and teachers who participated in the study answered the questionnaire. The questionnaire is applied in mode on-line, using the google-forms, and are answered anonymously.
In this paper, we have considered only the aspects that are shaded in Table 1, which are analyzed using the data collected from the questionnaire given to the students. Teachers were only required to evaluate the group report.

4.2. Analysis of interactions as cognitive units

The agent *student* is selected as *unit of analysis* and their behavior is analyzed during *interactions* with other agents of the system. Primarily, group work is taken into account mediated by ReSU system, i.e. *student-artifact-student* interactions. Through them, products are generated which will inform us about the state of these interactions, so that later, errors or problems that hinder the satisfaction of the necessities of distributed cognition could be identified.
First, a ***quantitative analysis*** is performed based on the responses obtained.
The first three questions (in Table 1) are related to the student's academic status: 22 students from the career of Information Systems, 5 from Teacher Training, and 5 from Computer Programmer Career (P_1). As to the level of advance in the professional degree (P_3): Of the total students, 29 are enrolled in the 2nd year and 3 are enrolled in the 3rd year (these ones attend the course for a second time). The coordinator role is played by eight students, while the remaining students worked on the role of reviewers (P_2). In questions 4, 5 and 6 the perceptions that students have about their own participation in the development of the work (individual or personal behavior) were analyzed, and also their perceptions with respect to interactions with peers and teachers (group or interpersonal behavior). The result is presented in Table 2. Most students said that their level of personal involvement in solving the proposed work was "very good" (P_5). Question 6 is divided into two questions in the student questionnaire ($P_{6\cdot1}$ and $P_{6\cdot2}$) and is oriented to the student-student and student-teacher interactions. Most of the surveyed students (36%) agreed that the level of exchange with their peers was "Very Good" ($P_{6.1}$), while the perception of the majority of students (42%) on the student-teacher interaction comes to be a "good" interaction ($P_{6.2}$).
The usability of ReSU was evaluated according to the aspects of *appearance*, *satisfaction* and *easy to use*. The question P_{12} was adapted and expressed differently

in the questionnaire (Table 3), to obtain an overall student assessment of the ReSU system (easiness for understanding of features and content, controllability, facility for navigation), and the presentation of user interface (legible, friendly, intuitive). In the two questions P_{12} and P_{13}, most students answered supporting the ReSU system.

Table 2. Perception of the student interactions

QUESTIONNAIRE	Not Good	Bad	Poor	Good	Very Good
$P_{5.}$ What was your level of participation in the group for the developing of the work proposed by the teacher?	0%	7%	27%	45 %	21%
$P_{6.1}$. Do you consider your level of interaction with your fellow students of the group has been ...	0%	4%	33%	36 %	27%
$P_{6.2}$. Do you consider your level of interaction with the teacher has been ...	9%	25%	42%	21 %	3%

Table 3. Perception of the usability of Artifacts

QUESTIONNAIRE	Suitable	Inadequate
	yes	No
P_{12}. In general, was the ReSU web tool easy to access and were their functions, navigation, control, clear?	100%	0%
P_{13}. Resu has a friendly, intuitive interface for use?	97%	3%

The responses obtained on the interaction between students and artifacts, specifically in this case, student-Wiki and student-Forum interactions are presented in Table 4. It is worth mentioning that 91% of the surveyed students said that, prior to this work, they had never used wiki, for example, in other classroom subjects ($P_{14\,1}$). Regarding the Forum application, 67% of the students stated that they had already used it elsewhere ($P_{14.2}$).

With respect to the facility that the Wiki and the Forum tools offer to work, the majority of the students answered that both were *easy to use* for this kind of activity (P_{15}). 82% of the respondents acknowledged that they find easy to use the Wiki, and for easy to use the Forum was a lower percentage (61%) ($P_{15.1}$ and $P_{15.2}$ respectively).

Table 4. Perception of student-Artifact interactions

QUESTIONNAIRE	Yes Suitable	No Inadequate
$P_{14.1}$ Have you previously worked with Wiki?	9%	91%
$P_{14.2}$ Have you previously worked with Forum?	33%	67%
$P_{15.1}$ Have you found it easy to use the Wiki?	82%	18%
$P_{15.2}$ Have you found it easy to use the Forum?	61%	39%
$P_{16.1}$ Does the use of Wiki prove to be better for group work?	100%	0%
$P_{16.2}$ Is the use of Forum better for group work?	67%	33%
$P_{16.3}$ Would you like to re-use the Wiki in future classroom activities?	100%	0%
$P_{16.4}$. Would you like to re-use the Forum in future classroom activities?	67%	33%

To assess the satisfaction with aspects of the use of artifacts, question 16 is broken into four items, to identify the perceptions of Wiki and Forum separately itemized. The responses indicate that all the surveyed students agreed that the use of Wiki has advantages in group work and would like to re-use the tool in future classes ($P_{16.1}$ and $P_{16.3}$). Regarding the Forum, 67% agreed that it has advantages in group work and would like to continue using the application in future classes ($P_{16.2}$, $P_{16.4}$).

With respect to the results on the interaction of students with the work environment, the obtained perceptions are presented in Table 5. Most students report having felt

comfortable working in groups in their homes, and the minority worked in labs or university cyber; likewise, they responded that the environment presented the necessary and sufficient characteristics with adequate connectivity (P_{21}).

Table 5. Perception of student-environment interactions

QUESTIONNAIRE	Adequate connectivity	Inadequate connectivity
	Labs	Home
P_{20}. Indicate the working environment where you made the proposed activities	24%	76%
P_{21}. Does the environment present the necessary and sufficient features to perform the tasks involved in the cognitive system?	65%	35%

Table 6 presents the results on the satisfaction that the student perceives in relation to the organization proposed in the classroom, for the resolution of the proposed work, mediated by ReSU. The majority of students considered that it favors the working conditions, promoting communication, collaboration and coordination, and they believe that the proposed modality of work is appropriate.

Table 6. Perception of student-environment interactions

QUESTIONNAIRE		Yes	No	Some times
P_{22}. If you compare it to the "traditional" group work, do you believe that this form of word(Organization) favors:	Communication	67%	14%	19%
	Coordination	15%	-	-
	Collaboration	86%	0%	14%
P_{23}. in general, do you consider that this **b**-learning modality of work is appropriate for use in classes?		65%	15%	30%

Finally, the group performance is assessed based on the technical report submitted by each group and evaluated by the teacher (P_{11}). The criteria considered for the assessment of the technical report are: precision in answers based on the object of study, use of technical vocabulary, organization and presentation of the work. Secondly, different interactions are evaluated ***qualitatively*** between agents of the system, taking the answers obtained from the questionnaires. In order to do it *units of meaning* are identified in each response, namely, text fragments representing signs of trouble in the interactions. Each unit of meaning is categorized according to the type of interaction that it involves. The following encoding is used for the categorization of the type of interaction: (student-student: **Iaa**); (student-teacher: **Iad**); (student-artifact: **Iar**); (student organization: **Iao**) and (student-environment: **Iae**).

In table 7 units of meaning are presented, drawn from the results of the questionnaires. In table 7, only the most relevant units for analysis are presented as examples, primarily, the units of meaning containing the perception of the student on the collaborative work mediated by computer, according to the "knowledge management tasks" factor (use and create, distribute and share), and the involved aspects of communication, collaboration and coordination (table 1).

In all the units of meaning of table 7, the tasks involved in the management of the knowledge are described, and a favourable attitude of the students during these tasks are shown (for example the task ***capture***: "search for information"; ***use***: "revise contents", "edit the report"; share: Each one gave input and feedback on the subject... Also a positive perception is shown regarding aspects of collaboration, coordination

and communication undertaken both individually and as a group (in the table are grouped and delimited by braces).
In table 7 the units of meaning are shown that explain issues related to the "usability" factor of ReSU user interface, and its appearance, ease of use and satisfaction. The units of meaning are illustrative and serve as a guide for interpreting problems or failures that occur during interactions. The units of meaning in table 8 are in the category student-artifact (Iar) interaction, however, they are not considered unique, since in some cases a unit of meaning implies more than one type of interaction. In these units, all student reviews, are evident as favorable towards certain aspects of the devices used. Such opinions, revealed in the units of meaning, are considered important because they would impact the contribution of a proper distribution of cognition in the implemented system.

Table 7. Units of meaning in the category Iar

ASPECT	UNITS OF MEANING	CATEGORY
Ease of use	*Wiki ... was not easy because it turned **difficult** **to upload** images*	**Iar**
	*Wiki ... the writing interface is **very complicated** and I needed **more resources** so that the work would be according to my idea.*	**Iar**
	The use of Wiki, after some practice, turned easier.	**Iar**
	*Wiki ... is complicated when all members are working and make **changes** at the **same** time.*	**Iaa**, **Iar**
	*The wiki is simple to use, just **is complicated** at the time of wanting to **edit at the same time** with others.*	**Iaa**, **Iar**
	***I did not understand** in the beginning how to use the forum...*	**Iar**
	*The use of the forum was not easy because it is in English and the **options** provided are not very clear to me...*	**Iar**
	*Wiki ... the system of conflict should be **improved** ...*	**Iar**
	*Maybe ... incorporating **reviews** to be able to go back in the past ...*	**Iar**
Appea-rance	***Videos** could be added to Wiki ...*	**Iar**
	*I would like **only** the group members and the teacher to be able to see Wiki, not the other students.*	**Iar**, **Iaa**, **Iad**
	*I do not believe forum to be of **much utility** for the work we do.*	**Iar**
Satisfac-tion	*I like Wiki, but I would have liked Wiki to have more **accessories,** E.g. to put **color** to the letters.*	**Iar**
	*It would be good to work more with wiki ... but what Wiki is **missing** **would** be a **chat** and a **simple way** of **attaching images**.*	**Iar**
	*It turned a very beneficial experience and learning to us... but a **disadvantage** is that there is a lack of **privacy** in wiki, because anyone outside our group can modify the information ...*	**Iar**, **Iaa**
	*Wiki has everything you need until the time of use, perhaps improving it with a **more friendly interface** could **facilitate** the environment and increase the allowed time for students to remain on the site.*	**Iar**, **Iaa**

In Table 8, problems associated with the interaction with artifacts are detected. The problems are related to the scope of system performance, technical quality and usability of the interface. The first two issues affect the possibilities to perform the tasks, because performance of the system indicates how far man can go with them, they are a mean to achieve goals efficiently and effectively. The usability of the interface mainly influences the ease of use, what often involves an extra cognitive load to the main objective pursued in group work. These problems directly affect the collaborative work. Some students suggest ways to improve the artifacts, for example, incorporate chat when working with Wiki, enable better synchronous communication, improve mechanisms for simultaneous work of users, and so on.

As for P_{22} and P_{23} questions, generally the opinions are considered positive, most students have a positive view with regard to the mode of work, for instance when they say: "we are from different cities, however we were able to work in groups", "working from home I had more comfort and time to read." However there were other observations about limitations in the organization, for example, some expressed about the lack of communication and/or coordination with the teacher in real time, and also some stated that the resources provided by the organization were scarce, and sometimes they had to leave the platform to find other materials and expand knowledge. These limitations shed light on the need for mechanisms to track and monitor the students while doing the work, allowing teachers to be able to address questions that arise in group work and to provide the resources needed for the development of activities. Further inconsistencies were detected from the perspective of the students about the usefulness of the artifacts (P_{17} and P_{18}). For example, some felt that the forum was not necessary to perform this work. But another student said the use of chat would have provided a better way of communication in real time. Safety issues are also present, although the virtual space is closed for students in this virtual environment; some students expressed the need of privacy for groups. This information is relevant because group members need to trust and feel safe in their context of work before transferring their knowledge, situation which often influences the process of communication and collaboration. The result of this case study indicates a positive effect on collaborative work mediated by the system. It generally improves the experience of using, creating and sharing knowledge. It motivates and encourages cooperative work, from the perspective of the student and also of the teacher. However there are a number of aspects to consider in future versions of ReSU, especially those related to improving the usability of the user interface and the technical capabilities thereof. Regarding the distributed cognition approach, their usefulness has been proven since it guides towards detailed level of analysis, which may offer clues on how to change the design of a device to improve the performance of users. Specifically, the contribution lies in the approach based on the distributed cognition; ReSU effectively supports knowledge management (create, use, distribute, share) in a collaborative academic context analysis. It has determined the effectiveness of working with ReSU and the needs of improving the design of the device, in particular of the UI, to promote group work and its key aspects of communication, coordination and collaboration.

4. Conclusions and future work

Overall, this work aims to reaffirm the fact that distributed cognition is a useful tool in the analysis of workspaces supported by computer. It is considered that in the conceptual approach of distributed cognition the more accessible it is, the easier it is to implement. It is considered important to have practical mechanisms to assimilate and implement distributed cognition in different situations and on different types of cognitive systems; to have results to guide the design of artifacts and improve learning strategies. Although the study in this part of the work has been limited and the outcomes obtained are incipient, they turn out useful to determine and to

understand the problems that take place in the interactions between the agents, in the light of the model of distributed cognition, and to anticipate so these flows will not happen in future experiences with the aid of improved designs of strategies and tools. This implies a deeper monitoring of agents: roles and cognitive operations which they accomplish, quality of the academic production, effects in learning and individual proficiency of the student, pending tasks for future development. Finally, the method will be applied to the whole ReSU system, with the intention of harnessing the production and the flow of knowledge in the same, and improving the opportunities for the development of collaborative tasks that are the base in the creation and the use of knowledge. This work is part of a larger project, where contributions of theoretical, methodological and practical type are expected. The first part will deal with determination, scope and implications of the models of distributed cognition in collaborative systems and knowledge management; secondly, the guides to orient the analysis and design of the user interfaces of collaborative system will be completed, emphasizing cognition and linking them with the usability attributes; and finally, as a practical result, a web system with an improved user interface and optimized user aspects inherent to distributed cognition will be obtained, with the aim of improving collaborative work and knowledge management shared by the group.

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