3rd International Conference on Industrial Engineering and Industrial Management
XIII Congreso de Ingeniería de Organización
Barcelona-Terrassa, September 2nd-4th 2009

Innovation and sharing of knowledge in learning organization

Jordi Ojeda[1], Rita Cadima[2], Josep Mª Monguet[3], Joaquín Fernández[3]

[1] Dpto. de Organización de Empresas. Instituto de Organización y Control de Sistemas Industriales. Universidad Politécnica de Catalunya. Av. Diagonal, 647, 08028. Barcelona. jordi.ojeda@upc.edu.
[2] Math Department and Informatics Department, Polytechnic Institute of Leiria, Portugal, rcadima@esel.ipleiria.pt
[3]Laboratorio de Aplicaciones Multimedia. Universidad Politécnica de Catalunya. Av. Diagonal, 647, 08028. Barcelona. jm.monguet@upc.edu, jfernandez@ege.upc.edu

Keywords: Knowledge sharing, Knowledge transfer, Knowledge networks

Abstract

Promoting collaboration and knowledge sharing through informal networks of relationships is increasingly important for organizations to compete in the areas of knowledge and innovation. Supporting awareness – to be aware of the ideas, knowledge, and activities of the others - has been used as one of the strategies to increase collaboration opportunities and efficiency. This study explores the concept of social awareness in a distributed Research and Development (R&D) community of forty researchers. For that purpose, a human-centered design tool was developed, the KIWI, for gathering data about the knowledge sharing processes. The early results have shown that the KIWI facilitates collecting information about the social interactions that allow knowledge transfer. Furthermore, the visualization of the knowledge networks, given as feedback, appeared to have a positive impact on the group, augmenting their social awareness.

1. Introduction

Scientific work processes can be seen as informal learning processes with a high level of social interaction that allows knowledge sharing and knowledge construction (Braun et al., 2007). Several studies have shown that one of the most effective channels for gathering information and expertise within an organization is its informal network of relationships (Ogata et al., 2001). Supporting collaboration and work in these informal networks has been increasingly recognized as important for organizations to compete on knowledge and on their ability to innovate and adapt (Cross, Borgatti & Parker, 2002).

In distributed work communities, information and communication technology (ICT) alone is not enough to facilitate knowledge sharing because it depends on social and human interaction that involves spontaneous participation, self-motivated choice, common goals and shared needs (Lin, 2007, Novak, 2005). To communicate and collaborate it appears very important to be aware of the ideas, knowledge, and activities of the others. In Computer-Supported Cooperative Work (CSCW) and Computer-Supported Collaborative Learning (CSCL), several conceptions of awareness have been applied: situation awareness, workspace awareness, group awareness, context awareness, knowledge awareness, social awareness (Zheng et al., 2007; Otjacques et al., 2006; Hu et al., 2002; Van Baren et al., 2004; Ogata et al., 2001). Awareness systems help people to effortlessly maintain this awareness, thus facilitating lightweight, emotional, and informal forms of communication, increasing collaboration opportunities and efficiency.

This exploratory research attempts to explore the concept of social awareness in distributed Research and Development (R&D) communities, which are understood as the awareness of the social relationships within the group. The purpose is to develop a system that measures the knowledge sharing that occurs through human interactions and provide this information back to users, allowing them to evaluate how much each one is receiving and giving to the community. This system should collect information directly from users, asking them systematically about the interactions that allow knowledge transfer and collecting data about all kind of interactions (face-to-face, mail, chat). Making these hidden networks visible to all of the community, without abstracting or evaluating users' actions, will allow each one to reflect about his/her role, and compare the reflected information to his/her own models of work and interaction in a process that might encourage communication and collaboration.

This paper describes the research surrounding the development of a new gathering tool and discusses the first findings noted by using this tool inside a distributed community. The next section describes the work methodology for the design and the first implementation of this tool. Subsequently, the results that come from the first attempt to measure the knowledge sharing and the results that come from users' evaluation will be presented.

2. Methodology

This study was conducted using a qualitative case study research design. We posed the question "What could be learned from the implementation of a system that measures the knowledge flow that occurs through human interaction in a distributed R&D community?" The indicators that could be used to measure this knowledge sharing have been explored and a first prototype of a collecting tool for gathering this kind of information was developed.

3. Participants

This study was developed within a distributed PhD community of thirty four PhD students and six supervisors – the Multimedia Engineering PhD Programme of Polytechnic University of Catalonia (UPC). This community is a typical example of an R&D multidisciplinary team that brings together different expert knowledge domains (engineers, designers, teachers, mathematicians, anthropologists, psychologists). There exists a central unit that works together at UPC settings in Barcelona, composed of twelve students and four supervisors. The other twenty four members work in their countries (Venezuela, Mexico, Colombia, Portugal, Denmark and other Spain cities) and primarily maintain virtually interaction with the rest of the group. The PhD studies took three to five years and during this time all members have some face-to-face contact with supervisors (once or twice a year). This community uses a web platform denominated COLS for information sharing and there are weekly seminars (virtual conferences) for individual research presentations. Most communications occur outside this platform through mail, chat, or, in some cases, face-to-face encounters.

In the beginning of this research work, a preliminary survey was developed through questionnaires applied to thirty PhD students and two supervisors of this community. This preliminary study allowed understanding of the work methods and the typical research activities of each person, as well as describing the existing networks of communication and collaboration in terms of the communication tools used, the patterns, the frequency, and the type of shared information and existing help. The community members were also asked about their satisfaction with the communication and collaboration that occurred and it was observed that the participants desired for more interaction. These results were similar to those found by Ferruzca & Monguet (2008) in their study. This information led to the decision to study more deeply and to promote the social dimension of awareness.

4. Instruments

KIWI: a Collecting Tool

In the design of the data gathering tool, two main goals were followed: it should allow registering every kind of interaction, from face-to-face meetings to mail and chat interaction; and it should be compatible with current users' behavior (the imposition of new communication tools could change the existing spontaneous informal network and would not ensure that all that was happening was being recorded). To meet these goals, it was decided that the users should be directly asked about their interactions: this led to the development of a simple Web-based data gathering tool, the KIWI. In this tool, users are presented with a list of community members (identified by name and picture) and can respond by clicking on those people with whom he or she has interacted during the last week.

In the preliminary study, one of the objectives was to know what kind of information was shared and what kind of help existed. Open-ended questions were made and the results showed that the existing processes of knowledge sharing could easily fit into Zheng, Ogata & Yano's (2007) classification. According to these authors, human knowledge is created and expanded through the social interaction between tacit knowledge and explicit knowledge. Explicit knowledge, or articulate knowledge, is defined as the kind of knowledge that is expressed in words, diagrams, or formulas that are easily codified, represented and shared asynchronously. Tacit knowledge, or inarticulate knowledge, is defined by the same authors as ineffable, contextual, based on personal experience, directly related to personal cognitive skills, embodies personal beliefs and values, and is communicated most effectively through face-to-face encounters. The KIWI was enriched by adding this classification. These definitions are presented to the users in the interface and they are asked to classify the knowledge transfers according to those. For each person the user must distinguish the giving or receiving (or both) character of the transfer.

The layout of the interface changes with ongoing use. After each user's first response, the community members selected in the previous sections appear in a specific individual area: Mi Red (My Network). In this way the effort for looking for regular co-workers is minor and, at the same time, the user can be more aware of his or her regular network.

Instrument for Users' Evaluation

An evaluation questionnaire was developed to be administered to the test group. The questionnaire had six open-ended questions organized to collect users' opinions about the usability of the collecting tool and how meaningful was the feedback information received about the knowledge networks.

Figure 1: *KIWI*'s interface

Test Group

Fifteen people took part in the field test for the four weeks implementation phase, eleven PhD students and four supervisors. Within this group, five students were physically apart (Portugal and Mexico) and the remaining students work at UPC, Barcelona. They were asked to complete the KIWI every week.

After four weeks of gathering data, the information collected about the existing knowledge networks was sent to the participants by e-mail. In this feedback, two types of information were provided: a) qualitative information – two social networks graphs were presented for explicit and tacit knowledge transfer, respectively (see figure 2); and b) quantitative information – two graphs were presented with the number of times each one of the fifteen people has receive and give knowledge. This information was anonymous: each participant was identified by a numerical code and each person knew only his/her own code.

One week later the evaluation questionnaire was sent by mail to the participants. Eleven completed questionnaires were received back, from nine PhD students and two supervisors.

5. Results

Experimental results

This section presents the data registered by the fifteen participants in the field test, during the four weeks of implementation of the KIWI. The knowledge networks can be visualized using the Social Network Analysis tool Ucinet (Borgatti, Everett & Freeman, 2002) (see Figure 2). As mentioned above, there were two different networks: one for explicit and one for tacit knowledge. Each node in these networks represents a person and each arrow represents a knowledge transfer. The direction of the arrows reflects the direction of the transfer from sender to receiver. The fifteen active participants are identified with red. It should be pointed out that only the interactions involving at least one of these fifteen users were registered in this field test. Triangles represent the supervisors while the PhD students are represented with circles and squares, according to their investigation phase beginner and advanced, respectively. The graphical distribution results from the pressure of the links: more interaction

(stronger link) results in closer nodes. From all the connections registered, 11% were for explicit knowledge transfer, 44% for tacit knowledge and 45% for both.

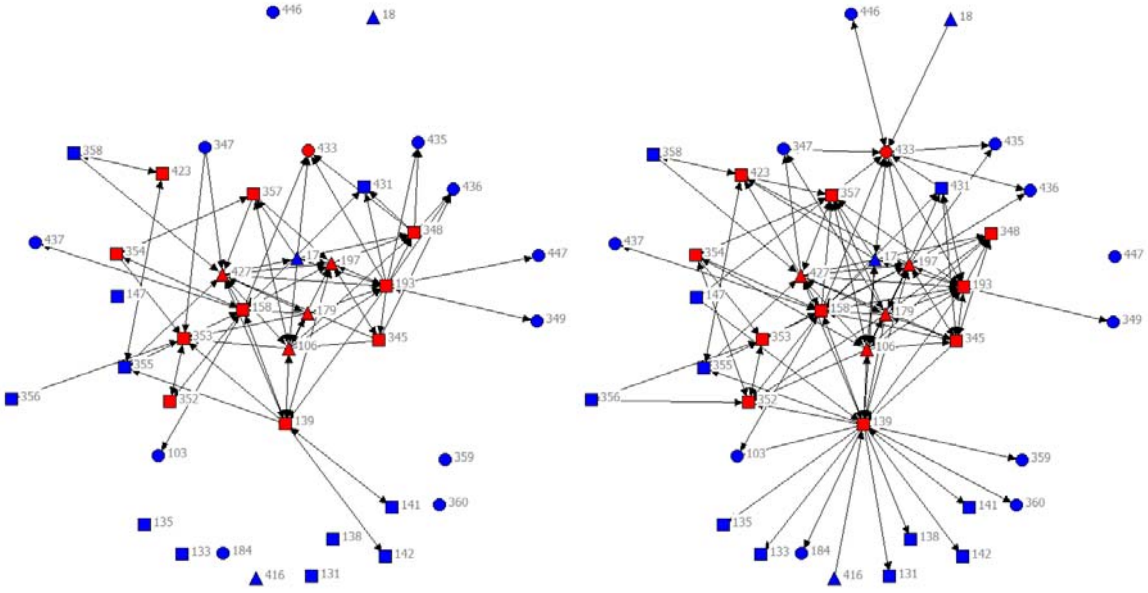

Figure 2: Knowledge networks for explicit and tacit transfers
Note: Each node in these networks represents a person. The direction of the arrows reflects the direction of the knowledge transfer, from sender to receiver. Red = active participants in the field test; blue = other people; circles = PhD students in a beginning phase; squares = PhD students in a final phase; triangles=supervisors.

During the four weeks, the fifteen participants registered a total of 287 transfers for knowledge receiving and 242 for knowledge giving. The means were 19.1 and 16.1 per person, respectively. Table 1 displays the comparison of these values by two types of groups: first, comparing the difference between the group that works at UPC and the group working at distance; second, comparing supervisors with PhD students. The results show that the UPC group had a higher level of interaction than the distance group; supervisors' group seemed to have higher levels of interactions, especially on giving knowledge. The high values of the standard deviations suggest that there was a great variability of behaviours among each group.

Considering the transfers only occurred between the fifteen participants, the reciprocity of the responses is displayed in Table 2. The percentage of transfers registered by both the receiver and the giver were 58.9% and 60.4% for explicit and tacit knowledge, respectively. In both cases there is a high percentage, 34.4% and 32.9%, of transfers that were registered only by the receiver, and 6.7% and 11.1% of transfers registered only by the giver.

	Knowledge receiving		**Knowledge giving**	
Groups	Mean	SD	Mean	SD
Presence group (n=10)	20.7	10.4	20.6	13.7
Group at distance (n=5)	16	8.5	7.2	4.8
Supervisors (n=4)	21.3	10.9	21.5	15.2
PhD Students (n=11)	18.4	9.7	14.2	12.3

Table 1: Mean by groups of the number of interactions registered for knowledge receiving and knowledge giving

Explicit knowledge transfer (n=90)		Registered by the giver	
		Yes	No
Registered by the receiver	Yes	58.9%	34.4%
	No	6.7%	-

Tacit knowledge transfer (n=149)		Registered by the giver	
		Yes	No
Registered by the receiver	Yes	60.4%	32.9%
	No	11.1%	-

Table 2: Percentage of transfers registered in each of three situations: registered by both receiver and giver, registered only by receiver or registered only by giver.

Users' Evaluation

This section presents a summary participants in the test group. All the respondents considered this tool was easy to use. They noted that it was simple to identify the knowledge transfers and apply the distinction between explicit and tacit knowledge, although three users (27%) referred to some initial difficulty and the need to access the definitions displayed in the interface. Five users (45%) remarked that this kind of classification allows them to reflect about their knowledge transfers. When asked about other possible classification for the knowledge transfers, only one person suggested that it may be interesting to differentiate physical and distance interaction.

When asked about the frequency of use, eight users (73%) considered that responding every week was the best way to collect data. They said that this process was quick and without more time lapsing between responses which would require additional effort to recall the interactions. The users who prefer more time between responses suggested there be a period of two weeks (2 users) or one month (1 user).

Regarding the information received, all the participants considered that the information displayed was relevant and that it allowed them to compare their own interaction with the other members of the community. Six persons (55%) explicitly stated that the visualization of the knowledge networks contributed to augmenting their awareness about the existing community networks and their own social interactions. Only one person said that he/she had some difficultly in interpreting the network graphs (Figure 2) and extracting meaningful information.

When asked about suggestions, nine users (82%) affirmed that the names should be in the graphs and that there was no necessity for protecting people's identity. Two users suggested that it will be relevant to know if the interactions they identified were identified in the same way by the other people involved.of the results of the evaluation questionnaire applied to eleven

6. Conclusions and future work

The results from the early study have shown that users can easily use the KIWI tool to give information about knowledge sharing. Also, the collected data allows the visualization of the knowledge sharing networks. This visualization was considered relevant by users and appears to have a positive impact, augmenting their social awareness.

This study had some limitations that should be acknowledged, namely the small size of the field test sample and the reduced time of implementation. Despite that, several interesting results arose. It was noted that the community made up by the central unit of persons in UPC were able to centralize a significant amount of knowledge transfer, mainly the knowledge giving. It was possible to observe that this community has a high level of tacit knowledge sharing (89% of interactions include some tacit exchange), as opposed to the idea that this kind of knowledge was difficult to share in distributed communities. There were 40% of no correspondent answers between the fifteen participants, with transfers registered only by the

receiver or by the giver. These results could give some relevant information and deserve further attention in the future to identify newer or deeper analysis.

Although the subjectivity of using participants' perception, the 60% of congruency in the responses (transfers registered by both giver and receiver) could give some confidence about the data collected. Furthermore, this option appears to have the advantage that users select and only register the interactions they believe to be significant.

The redesign and evaluation of a new version of this system are currently in process. A first step will be the validation of an already developed prototype of a visualization tool. This first experience gave support for the design of this new tool which will automatically use data from the gathering tool and will present in real time to the users the visualization of the knowledge transfers occurring. The implementation of this new system will be extended to the whole community (forty people) and it will be tested during a longer implementation phase.

References

Borgatti, S.P., Everett, M.G., & Freeman, L.C. (2002). Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Braun, S., Schmidt, A., & Hefke, M. (2007). A Socially-Aware Desktop for e-Science: Supporting Learning in Networked Scientific Processes. In: 4th Conference on Professional Knowledge Management - Experiences and Visions (WM 2007), Workshop on Collaborative Knowledge Management (CoKM), GITO, 47-54.

Cross, R., Borgatti, S. P., & Parker, A. (2002). Making Invisible Work Visible: Using Social Network Analysis to Support Strategic Collaboration. California Management Review, Vol. 44, No. 2, 25-46.

Ferruzca, M., & Monguet, J. M. (2008). Estudio Teórico y Evidencia Empírica de la Aplicación del Marco Teórico de «Cognición Distribuida» en la Gestión de Sistemas de Formación e-Learning. Barcelona: Universidad Politécnica de Catalunya. PhD Tesis.

Hu, B., Kuhlenkamp, A., & Reinema, R. (2002). Supporting Group Awareness in Web-Based Learning Environments. Lecture Notes in Computer Science, Vol. 2480, 525-536.

Lin, H. F. (2007). Knowledge sharing and firm innovation capability: an empirical study. International Journal of Manpower, Vol. 28, No. 3/4, 315-332.

Novak, J., & Wurst, M. (2005). Collaborative Knowledge Visualization for Cross-Community Learning. Lectures Notes in Computer Science, Vol. 3426, 95-116.

Ogata, H., Yano, Y., Furugori, N., & Jin, Q. (2001). Computer Supported Social Networking for Augmenting Cooperation. Computer Supported Cooperative Work. The Journal of Collaborative Computing, Vol. 10, No. 2, 189-209.

Otjacques, B., Noirhomme, M., Gobert, X., & Feltz, F. (2006). Cooperation Indexes to Support Workspace Awareness. 12th International Workshop, CRIWG 2006. Lecture Notes in Computer Science, Vol. 4154, 94–101.

Van Baren, J., IJsselsteijn, W., Markopoulos, P., Romero, N., & De Ruiter, B. (2004). Measuring affective benefits and costs of awareness systems supporting intimate social networks. In A. Nijholt, & T. Nishida (Eds.), Proceedings of 3rd workshop on Social Intelligence Design. CTIT Workshop Proceedings Series WP04-02, 13-19.

Zheng, Y., Li, L., Ogata, H., & Yano, Y. (2007). Support online social interaction with Context-Awareness. International Journal of Continuous Engineering Education and Lifelong Learning, Vol. 17, No. 2/3, 160-177.