This is a draft version for: Pifarré, M.; Cobos, R. & Argelagós, E. (2014). Incidence of group awareness information on students' collaborative learning processes. Journals of Computer Assisted Learning, 30 (4), 300-317 . DOI: 10.1111/jcal.12043

Incidence of Group Awareness Information on Students' Collaborative Learning Processes

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Abstract

This paper studies how the integration of group awareness tools in the Knowledge Management system called KnowCat, which promotes collaborative knowledge construction, may both foster the students' perception about the meaningfulness of visualization of group awareness information and promote better collaborative processes as well as enhance better task performance.

Forty-seven university students participated in a research study, where one group of 23 students used KnowCat without the awareness console (non-awareness group); the other 24 students used Knowcat with the awareness console (awareness group). Both groups used KnowCat during one semester. Data analysis revealed that the awareness group means were higher than those of the non-awareness group in terms of participation, cognitive and metacognitive learning activities, and task performance. Moreover, students revealed that knowing what, where and how much their classmates were contributing acted as positive feedback by encouraging participation and orienting their own behaviour and their contribution to the collaborative work. In this paper, we claim that the visualization group awareness information in KnowCat, a utility allowing students to visualize and track what, where, how much and how often others participants contributed to the KnowCat knowledge area, had a positive impact on the students' collaborative behaviour.

Keywords

Group awareness

Computer-Supported Collaborative Learning

Collaborative Learning Processes

Peer feed-back

Metacognition

Instructional guidance

1. Introduction

Work groups need information about one another, about shared artefacts and about group processes. This information is often associated with group awareness (Briggs, 2006). It refers to being informed about specific aspects of group members such as other participants' locations in the shared area (where are they working?), their actions (what are they doing?), their interaction history (what have they already done?), their intentions (what are they going to do next?), and their knowledge (Bodemer & Dehler, 2011; Gutwin & Greenberg, 2002; Gross, Stary & Totter, 2005).

In collaborative learning scenarios, awareness of partners' cognitive and social activities is a relevant variable because awareness tools may help collaborators to overcome problems related with communication, engagement and coordination of the group work (Carroll, Neale, Isenhour, Rosson & McCrickard, 2003). With a view to doing research on group awareness, Computer-Supported Collaborative Learning - henceforth, CSCL- aims at developing tools that could effectively support group members and studying the relationships between awareness and learning (Buder, 2011).

To this end, the study described in this paper applies group awareness tools to a Knowledge Management system called KnowCat (Cobos, 2003) to help group members raise awareness on the other's activities in a collaborative learning environment. The ultimate aim of

our research is to study how the integration and use of group awareness tools in a CSCL environment affects the students' collaborative learning activities and task performance.

2. The possibilities of group awareness tools in supporting collaborative learning

Research on group awareness in CSCL environments is emerging judging by the broad scope of group awareness applications existing nowadays. Bodemer and Dehler (2011) established three essential group awareness types for effective collaborative learning, namely, social, cognitive and behavioural awareness.

Social awareness indicates the functioning of the group as perceived by the collaborators. This type of awareness informs of the presence or availability of other members of the community and assesses social behaviour patterns such as cooperativeness, friendliness, influence or reliability. Some studies indicate that social processes may allow group members to know and understand each other in order to become a community of learning and a better development team to collaboratively solve the problem (Kreijns, Kirschner & Jochems, 2003). In this respect, Phielix, Prins, Kirschner, Erkens & Jaspers (2011) expanded the concept of a CSCL environment by means of a peer feed-back tool (radar) and a reflection tool (reflector). They examined the incidence of a CSCL environment on both perceived social and cognitive group behaviour and on the social and cognitive performance of the group. The study concluded that the combination of peer feedback to foster interpersonal behaviour and the reflection of feedback enhanced group-process satisfaction and social performance.

Cognitive awareness refers to the knowledge of group members. It gives information about self and partners' self-assessed knowledge, cues about knowledge of the other group members, type of knowledge contributed by others or distribution of knowledge in collaborative learning scenarios. Dehler, Bodemer, Buder & Hesse (2011) proved that tools providing

partners' knowledge were based on the availability of learning content, performance in a knowledge test or opinion ratings in a questionnaire. The study also demonstrated that reliable knowledge-group awareness could promote better management of the diversity of the group mates' knowledge in order to successfully reach the purposes of the collaborative task.

In this line of research, Romero (2011) reported on improved students' knowledge group awareness when using a CSCL system called EuroCat. This system consists in an interface which allows students to state their status and knowledge of the different aspects of the task. The study showed how unfamiliar students, i.e. having zero-history group with the online master course, managed to evaluate their group mates' knowledge more accurately and increased their knowledge group awareness as a result of using the knowledge awareness tools provided by the learning environment EuroCat.

Behavioural awareness indicates the learners' activities within the CSCL environment such as what the participants are doing, how much, how often and where. One of the main approaches to developing behavioural awareness is to visualize important information that can help individuals to know what, how and how much the other group members are contributing to solve the collaborative task. Visualizations can display and facilitate the collection and interpretation of crucial information for better collaboration because they create a complex conceptual structure represented externally in a visual display (e.g., Jiang, Elen & Clarebout, 2009; Kimmerle & Cress, 2009).

Several studies have implemented visualizations about different aspects of individual contributions to the collaborative task and have analysed their impact on the collaborative processes and task performance. In this line of argument, Janssen, Erkens & Kirschner (2011)

investigated the potential of a participation awareness tool, which visualized the group members' relative contribution in an online writing collaborative task. The study argued that whenever students participated actively during online collaboration and participation was divided equally among group members, every single member of the group had the opportunity to contribute to the problem-solving process, participate in knowledge construction, give or request explanations, and use and refine his/her skills. This study also reported on the higher incidence of students using the participation awareness tool in online discussions during the collaborative writing process. The participation awareness tool also promoted equal participation within the group, and better coordination and regulation of group activities in the relational area. However, the increase in awareness participation of this study did not guarantee better group performance.

Other studies have emphasised the fact that behavioural awareness tools can generate better external feedback among group members because they provide group members with feedback on how adequately they are collaborating. Educational literature highlights the importance of scaffolding processes among peers, especially the processes for giving and receiving assistance to favour better collaborative learning (e.g. Scardamalia & Bereiter, 1994; Hakkarainen, Lipponen & Järvelä, 2002; Pifarré, 2007).

An example of how group awareness tools can be embedded in CSCL environments to give feedback to group members has been extracted from research by Zumbach, Reimann and Koch (2006). These authors embedded a collaborative environment in management-based scaffolds whose collaborative online learning environment was enriched by functions as tracking, analysing and feeding back parameters of participation, collaboration, motivation and emotional state of group members. Zumback et al. showed that a positive influence of feeding

back the groups and its re-use on participants influenced the learners' group behaviour, as well as their problem-solving, emotional and motivational parameters.

To sum up all the above, enhancement of students' group awareness by means of tools providing information about key aspects of group collaboration can, in turn, help students monitor their collaborative behaviour in order to better contribute to solve a collaborative task. However, as pointed out by Buder (2011) further research is required on such issues as (i) what display method of the group collaborative behaviour is most appropriate in a given context, (ii) what information should be displayed and (iii) what collaborative processes should be monitored. Our study attempts then to delve further into these issues. This paper gives a detailed account of this study.

3. Description of the KnowCat system

KnowCat (acronym for "Knowledge Catalyser") is a fully consolidated and thoroughly tested and validated CSCL system which has been developed at Universidad Autónoma de Madrid (Spain) in active use since 1998 (Alamán & Cobos, 1999; Cobos, 2003). The main aim of this system is to generate quality educational materials as the automatic result of student interactions with the materials, by catalysing the crystallisation of knowledge. More specifically, the system is based on a mechanism called "Knowledge Crystallisation". The mechanism supplies evidence for what the best contributions are, in the users' opinion, through interaction with the system. A full description of the system and the experimental studies carried out so far can be consulted in Cobos (2012) but a brief description can be found below.

KnowCat enables to build up community knowledge sites called "KnowCat sites" or "KnowCat nodes". Each knowledge site is organised around the following knowledge elements:

1) the knowledge tree, based on a hierarchical structure of topics, displays the organisation of the knowledge site in several topics. 2) Each topic contains a set of mutually alternative documents that describe the topic. 3) At any time, the author of a document can contribute with a new version of his/her document. 4) Each document can receive annotations –or notes, for short–, with a review of the information presented in a document. Each note belongs to a type that determines its purpose. The three note types are: clarification, support and review. 5) Finally, each document can receive assessments. An assessment represents a “weight assertion” which can be utilized by the users in order to determine the quality (with a value from 1, minimum value, to 10, maximum value) of a specific aspect (i.e., correctness, innovation, etc.) of a specific part of a document (i.e., introduction, references, etc.).

The main aim of this paper is to show how KnowCat can be improved when using group awareness tools. To this end, six group awareness tools were integrated in KnowCat, as shown in Figure 1. These tools were called: Registered Users, On-line Users, Radar View, Notes View, History View, and Participation View. These KnowCat awareness tools are briefly described below.

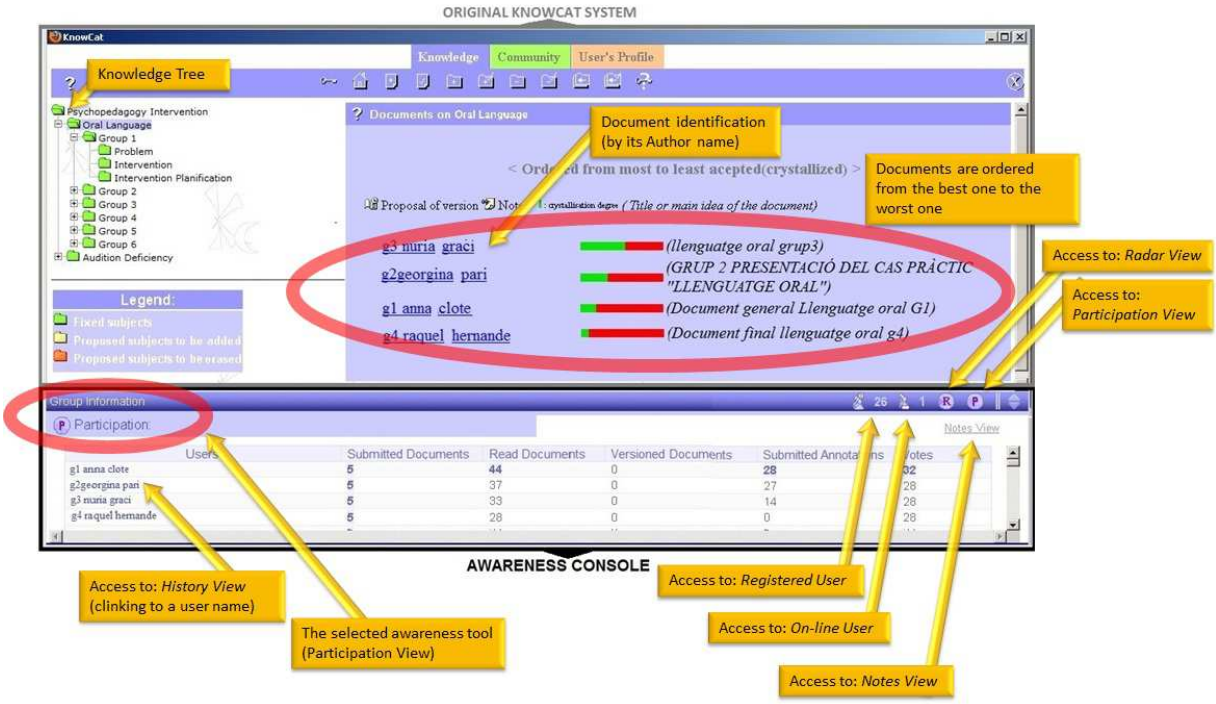


Figure 1. Screenshot of the KnowCat site called ‘Psychopedagogy Intervention’; the awareness console is shown in the Group Information part.

a) *Registered Users* provides brief information about the registered users in KnowCat; in other words, who are my partners?

b) *On-line Users* provides information about the contact data and the current location of a selected user; in other words, who is on-line and where is s/he working?

c) *Radar View* provides the locations of the on-line users through a replicated knowledge tree of the KnowCat site (Figure 2). In each topic of the replicated knowledge tree, the number of on-line users and who is interacting in each topic is shown; in other words, where and what are the connected users doing?

Figure 2. Example of Radar View awareness tool

d) *Notes view* provides graphical information about interaction among users in the annotating task. Users can consult which document was annotated, who annotated it and what was annotated (Figure 3). With this tool, the users can see graphically how the annotation process is going on among the different group members – Who by, What about and Who to was a document annotated. It is expected that knowing how the feedback process is been performed with the small groups may positively affect a group's collaborative behaviour.

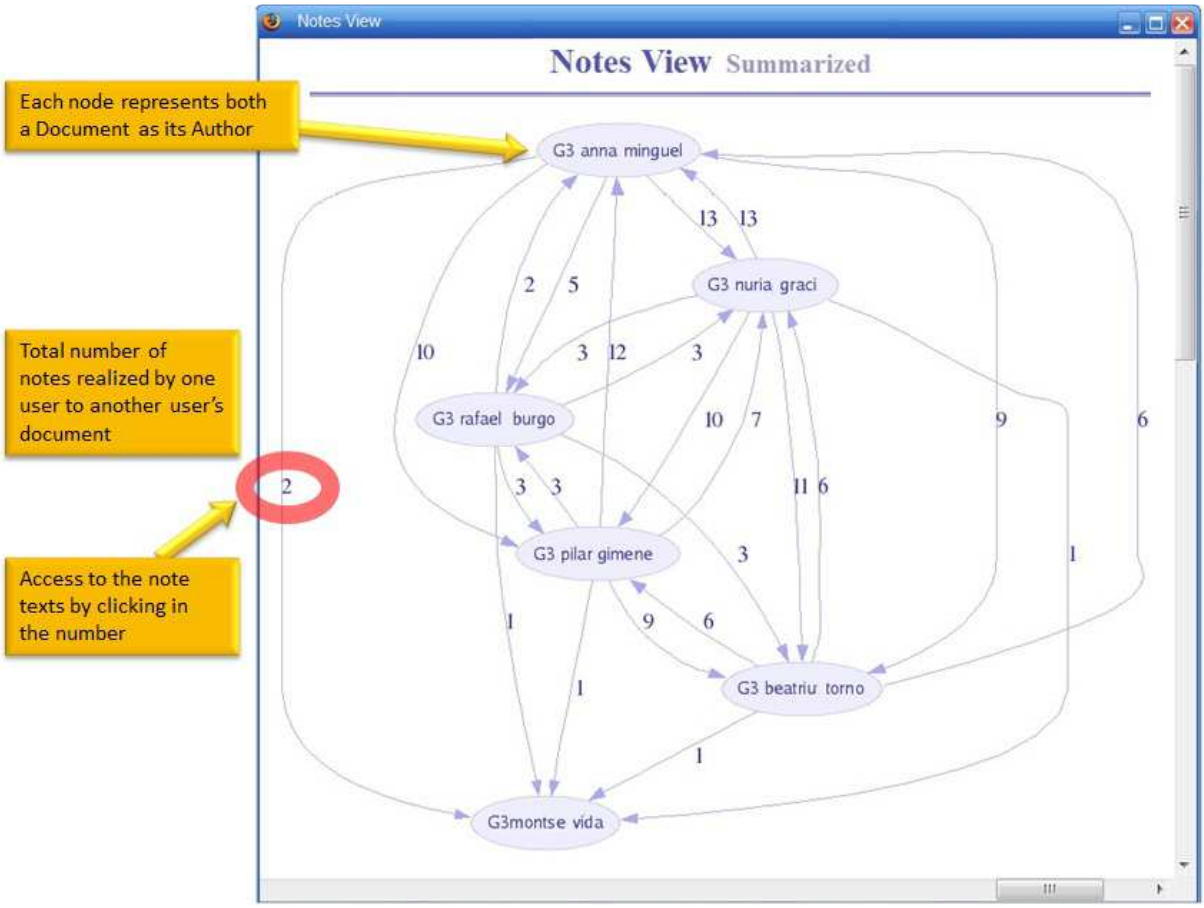
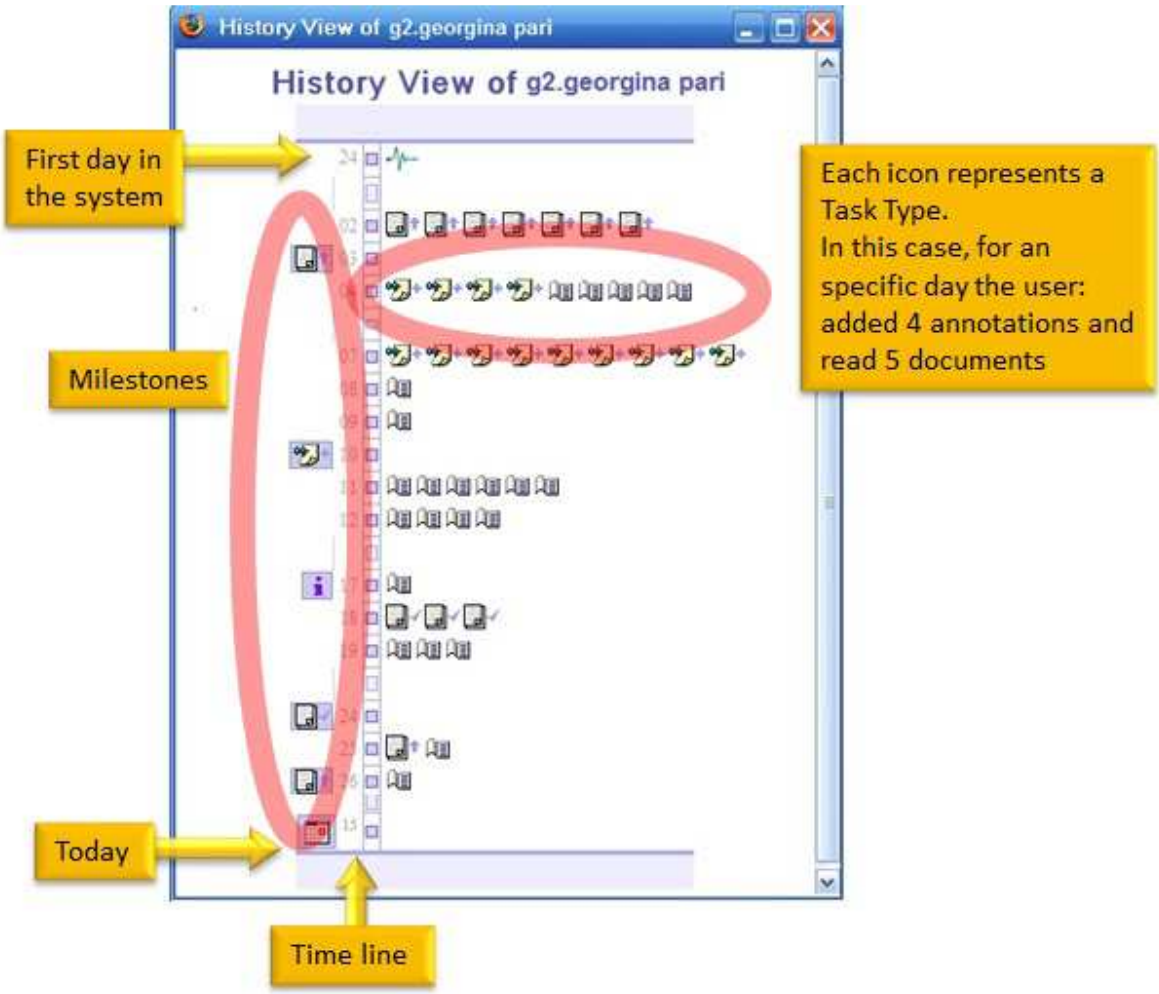


Figure 3. Example of a part of the Notes View visualisation tool

e) *Participation view* displays in a table the number of contributions of each participant for each knowledge element, namely, the number of documents added, the number of new document versions, the number of notes added, and the number of votes. Besides, this tool also displays the community average for each knowledge element. In addition, the participation view offers the option to display the members of the community arranged in ascending or descending order depending on the number of contributions made in a specific knowledge element (bottom part in Figure 1).

f) *History view* displays chronically and graphically information about the tasks realized by each user. Furthermore, as Figure 4 indicates, on the left side of the *history view* are displayed the milestones agreed by the community in order to fulfil collaborative work. Therefore, students can compare their own work with that done by other group members and with what they should have done in order to reach effective collaboration. This tool may guide students through the progress of their own behaviour and motivate them to further contribute to the collaborative process.



-Figure 4. Example of the History View

Moreover, all the information visualized in all KnowCat awareness tools can be clicked on and students can track down and consult the classmates' knowledge submitted to the system: documents, notes or versions. From our perspective, the possibility to easily track down the knowledge submitted to the collaborative knowledge area might provide valuable group awareness about how knowledge is collaboratively constructed and distributed in the system. Furthermore, this awareness might give users many opportunities to monitor and regulate their own actions.

4. Research questions

The four initial research questions asked in our study were the following:

1. How meaningfully do students perceive the information provided by the different group awareness tools in KnowCat for effective collaborative learning –in terms of social and behavioural awareness?

2. Does the use of group awareness tools in KnowCat encourage students to give more feedback –behavioural awareness- in terms of sending more notes to their peers, compared with the use of the system without such tools?

3. Does the use of group awareness tools in KnowCat promote better students' collaborative learning activities – in terms of affective, cognitive and metacognitive activities- compared with the use of the system without such tools?

4. Does the use of group awareness tools in KnowCat enhance better students' task performance compared with the use of the system without such tools?

5. Method

5.1. Participants

Forty-seven university students participated in the study. They were divided into two groups. One group of 23 students, called “non-awareness group” used KnowCat without the awareness console. The remaining 24 students, called “awareness group” used KnowCat with the awareness console. Both groups consisted of the natural class for the academic term and used KnowCat during a one-term period of the regular university course called: Psycho-pedagogical intervention in developmental disorders (Degree in Psychopedagogy at the Universitat de Lleida, Spain). Both groups followed the same instructional process, as described in the next section.

In order to guarantee the reliability in the selection process of participants from both awareness and non-awareness groups, we analysed the students’ marks obtained in the previous curricular course –called Instructional Psychology. The Mann-Whitney non-parametric test (95% significant level) revealed no statistical significant differences between both groups (non-awareness group: N=23, M=7.78, SD=0.89; awareness group: N=24, M=7.39, SD=2.03; p=0.888). It can be noted that the awareness group has a higher standard deviation than the non-awareness group because 78 % of the marks of the non-awareness group ranged between 7 and 8.9 points (in a range between 0 and 10) and 75 % of the marks of the awareness group students ranged between 7 and 10. Despite that, we could consider both groups as statistically comparable.

5.2. Procedure

Students of both groups followed the course face-to-face and they solved on-line two authentic problem-based tasks using KnowCat. The tasks presented real cases of children with learning difficulties, to which students had to design specific educational intervention in order to

better overcome these difficulties and promote the children's better development. The non-awareness group used the KnowCat version *without* the awareness console while the awareness group used the KnowCat version *with* the awareness console.

In order to assist all the students in the use of KnowCat to construct knowledge collaboratively, i.e. the use of KnowCat notes as improved scaffolds that could help their classmates improve their documents, we designed a specific educational process integrating pedagogical prerequisites pointed out in CSCL literature.

To solve both tasks, students worked with the assistance of KnowCat at two collaborative levels: in small group level in phase 1, and in class group level in phase 2 (see Figure 5). The main aim of the students' work with KnowCat in phase 1 –"working in small groups"– was to elaborate an educational group intervention report that responded to a real educational case presented in the task. The steps of the methodology of the collaborative small group procedure in phase 1 were the following:

a) Each student wrote an individual report containing the individual resolution of the real case and submitted it as a document to the KnowCat platform.

b) The other members of the small group read each peer's report separately and annotated them –i.e. gave assistance– with a view to helping a fellow classmate improve on them.

c) The document author then read the notes concerning his/her own report taking into account the classmates' notes and documents, re-wrote his/her own document and submitted it back to the system as a new document version. When students re-wrote their document, they

could introduce ideas included in their classmates' reports because the objective of re-writing the document was to elaborate collaboratively the best educational group intervention for each real case.

d) The members of each group voted for the best report which, in their opinion, contained the adequate response to a real educational case. Then the best socially acceptable report (calculated with the KnowCat Knowledge Crystallisation mechanism) was submitted to the system in the "class section" as a group report, and shared it with the other (small) groups of the class. The educational project presented the voting process as a collaborative action rather than a competitive one. At the beginning of the project, the students shared the common objective of collaboratively finding and arguing the best and adequate response to real problems presented in each task by giving individual feedback to their peers in the form of notes and votes.

The aim of the students' work with KnowCat in phase 2 –"working with the whole class"– was to decide which small group report was, in the opinion of the class community, the best educational intervention for each real case. The procedure in phase 2 was as follows:

a) Students read all the reports submitted by the six small groups and voted for the best one. Students argued their reasons in the voting process.

b) KnowCat Knowledge Crystallisation mechanism helped select the best socially accepted document of the whole class.

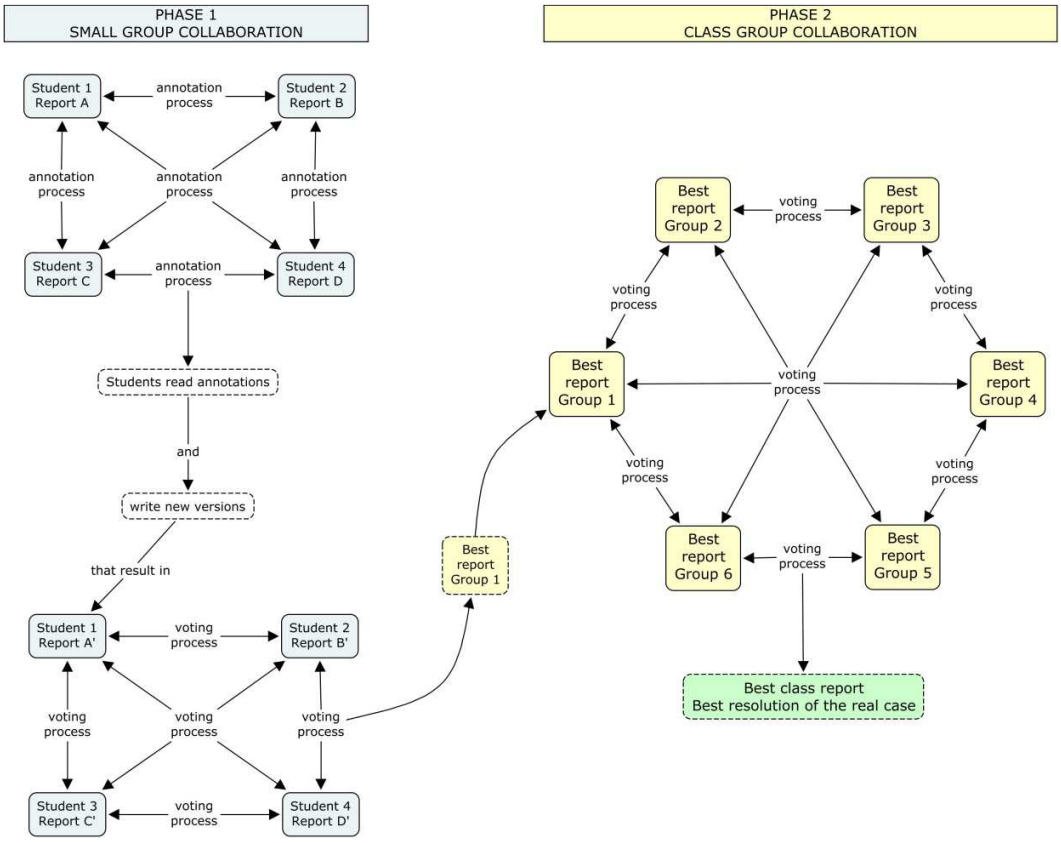


Figure 5. Pedagogical intervention and use of the KnowCat system

5.3. Instruments and Data Analyses

With a view to providing a solution to our first research question –*to study the students' perception about the meaningfulness of the information provided by the KnowCat group awareness tools for effective collaborative learning; in terms of social and behavioural awareness*–at the end of the semester, awareness students group were administered a survey questionnaire to collect data on their collaborative work with the system. This questionnaire had been previously tested in some of our research studies (Cobos, Claros & Moreno, 2009; Cobos 2012). The questionnaire was divided into 3 sections:

Section 1: Questions related with time invested in using the knowledge elements of the system such as documents, versions and notes.

Section 2: Students' perception about how the different knowledge elements (documents, notes, assessments and votes) promoted collaborative learning activities.

Section 3: Students' perception about each awareness tool in relation with: usability, presentation, frequency of use and usefulness in promoting collaboration and collaborative learning activities. The development of the items of this section was based on work presented by Gutwin and Greenberg (2002).

The questionnaire had a total number of 40 questions. The students answered the questionnaire using a 4-point Likert scale in which students were asked to use a punctuation between 1 and 4 (1, minimum value and 4, maximum). The answer format was adapted to the content of the questions of the questionnaire. For example, the answer format for the frequency questions was: 1 = never; 2 = rarely; 3 = occasionally; 4 = frequently; the answer format for quality questions was: 1 = poor; 2 = barely acceptable; 3 = good; 4 = very good. The percentages of the students' answers were then calculated for each question. Besides, the students had a blank area for comments and arguments on their answers.

Two examples of section 3 of the questionnaire are shown below:

The information displayed in the Participation view encourage you to contribute with a new element in KnowCat (submit a new note, new assessment or new document)?

1 = never; 2 = rarely; 3 = occasionally; 4 = frequently

The information displayed in the History view was:

a) Usefulness:

1 = poor; 2 = barely acceptable; 3 = good; 4 = very good

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b)	**Well formatted presentation and easy to read:**
1 = poor; 2 = barely acceptable; 3 = good; 4 = very good	
c)	**Frequency of use during the collaborative resolution of the task:**
1 = never; 2 = rarely; 3 = occasionally; 4 = frequently	
d)	**Useful for the collaborative resolution of the task:**
1 = poor; 2 = barely acceptable; 3 = good; 4 = very good	

As regards our second and third research questions –*to analyse the impact of the implementation of group awareness tools in KnowCat on collaborative behaviour and on the promotion of collaborative learning activities compared with the use of the system without awareness tools*– detailed content analyses of the notes submitted to the system were carried out.

A coding scheme was used to study possible differences in the content of the notes and in the learning activities involved in writing the notes during the solution of the problem-based task between the awareness and non-awareness groups. The coding scheme was based on the categories developed by Veldhuis-Diermanse (2002), which had been used in some of our previous studies (Pifarré, 2007; Pifarré & Cobos, 2009; Pifarré & Cobos, 2010). The scheme established three general types of learning activities (or categories) and nine subcategories: (1) cognitive activities –containing the following three subcategories, debating ideas, using external information and experiences, and linking or repeating internal information; (2) metacognitive activities –containing the following three subcategories planning, keeping clarity, and monitoring; (3) affective activities –containing the following three subcategories, general reaction, asking for general feedback, and chatting or social talk. Appendix 1 includes a description and examples of each subcategory of the coding scheme.

The coding process consisted of two steps: a) dividing the messages into meaningful units, and b) assigning a code to each unit. We decided to segment the notes into units of meaning by using semantic features such as ideas, argument chains, and discussion topics, or by

regulating activities such as making a plan, asking for an explanation, or explaining unclear information.

To ensure objectivity in the coding process, validity and reliability aspects were considered in the study. Two evaluators of our research group with experience in this type of coding processes participated in the segmentation and categorization process. In the first step, both evaluators categorised 5% of the total notes separately. In order to develop the coding rules and achieve reliability, from those notes which the evaluators categorised differently, a common view was negotiated. In the second step, both evaluators categorised 25% of the total notes separately. The Cohen's Kappa coefficient for both was as high as 0.92. The rest of the notes were coded by one evaluator.

Finally, in order to answer our fourth research question *–to examine the impact of the implementation of group awareness tools in KnowCat on students' performance compared with the use of the system without awareness tools–*, both instructors of the course marked the quality of the individual report that each student re-wrote after the annotation group collaboration process with KnowCat. Although this report was re-written and submitted individually, it had to include the best ideas supplied by the members of the small group –both in their individual report and in the notes- in an attempt to solve the task better (phase 1 of Figure 5). Each instructor marked one of the two tasks solved in collaboration, by using KnowCat because of his/her expertise on the topic of the report -a specific child learning difficulty. Each report was marked using a punctuation mark between 0 and 10 and both instructors agreed on the indicators to assess the quality of the reports. These indicators referred to the adequacy of the subject contents and how students built adequate and convincing arguments to justify the educational intervention proposed to solve the tasks.

The Mann-Whitney independent non-parametric test (95% significance level) of the SPSS software was run in order to analyse whether there were statistical differences between the awareness and non-awareness group in relation with the variables: a) learning activities (or categories), namely: cognitive, metacognitive and affective and b) task performance.

6. Results

6.1. Students' perception about the meaningfulness of visualization of group awareness information.

The questionnaire was answered by 17 out of 24 students of the awareness group. In the questionnaire, 63% of students answered that visualising their classmates' participation motivated them to contribute with knowledge in KnowCat (e.g. uploading documents, contributing with notes…). Furthermore, students pointed out that frequently (76%) or occasionally (24%) compared their participation with that of their classmates. These results showed that knowing what and how much their classmates were contributing acted as positive feedback which both encouraged students' participation and monitored their behaviour.

As regards the frequency of use of the group awareness console, calculated on a scale between 1 (never) and 4 (frequently), students reported an average of 2.5 (Figure 6). The awareness tools most used by the students because of their useful information in accomplishing the collaborative task were *Participation View*, *History View* and *Notes View*. It should be noted that all of these tools provided graphical information about their classmates' contribution. Kimmerle and Cress (2009) pointed out the potential of a graphical approach in designing specific group awareness tools.

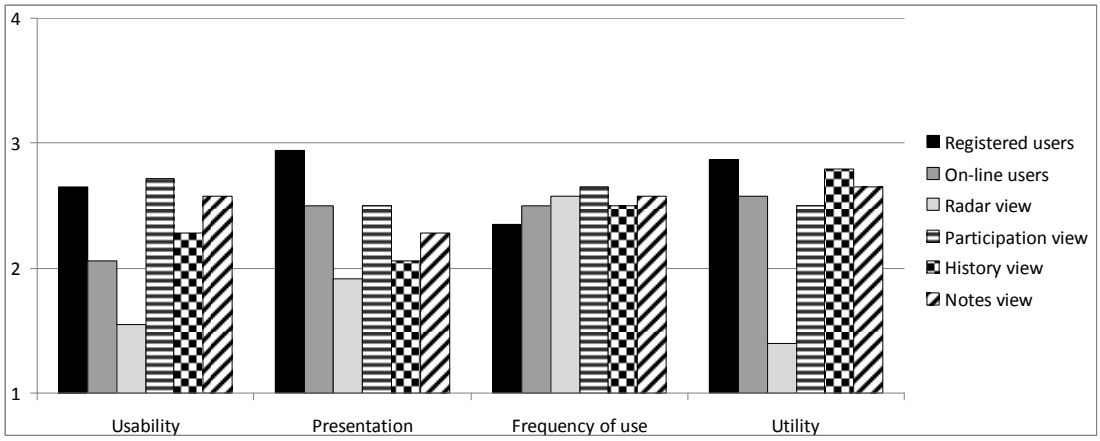

Figure 6. Students' opinion about the awareness tools provided in the KnowCat system

Our study will take into consideration the weak points reported by students on such areas as *usability* and *information presentation* of the different awareness tools (see Figure 6). Results showed then that the *Radar View* was the awareness tool less valued by the students. This result could be partially explained because KnowCat is an asynchronous system that does not supply ways of communicating and interacting among community members. Thus, knowing who and where a team partner is working on-line is not relevant in fulfilling the collaborative task.

6.2. The use of awareness tools in KnowCat encourages students to give more feedback to their peers compared with the use of the system without awareness tools.

In order to know whether the use of group awareness tools in KnowCat encourages students to give more feedback to their peers by posting a higher number of annotations on classmates' reports, we compared the number of notes posted by the awareness group with those posted by the non-awareness group (research question 2). The awareness group posted a total number of 559 notes (M = 23.29; SD = 9.16) while the non-awareness group posted only 371 notes (M = 17.52; SD = 4.71). The Mann-Whitney independent non-parametric test (95% significance level) of the SPSS software was run in order to analyse whether there were

statistically relevant differences between both groups of students in relation to the number of notes posted. No statistically significant differences were found ($p = 0.082$). However, it should be noted that the differences between both groups were close to be statistically significant in favour of the awareness group. In addition, it should be considered that the awareness group students reported in the questionnaire that the awareness information motivated them to participate in the system. It can therefore be concluded that the group awareness tools allowing students to visualize what, where, how much and how often other participants contributed in the KnowCat knowledge area, had a positive impact on the students' collaborative behaviour as it increased feedback.

6.3. The use of awareness tools in KnowCat promotes the development of better collaborative learning activities compared with the use of the system without awareness tools.

In order to study the incidence of group awareness information on the content of the notes and the learning activities required for writing the notes between the awareness and non-awareness groups (research question 3), we analysed the content of the notes written by the students during phase 1 –"working in small groups" (see Figure 5). To this end, we used the coding scheme presented in section 5.3 and shown in Appendix 1.

As a new dependent variable, we calculated an individual score of the proportion of affective, cognitive and metacognitive meaningful units. Thus, the individual score of each student showed in which proportion s/he developed affective, cognitive and metacognitive learning activities in his/her notes. As a result, the proportion of affective, cognitive and metacognitive learning activities reached 100% for each student. This individual score

compensated the fact that awareness group students posted more notes than the non-awareness group.

Awareness group showed a higher number of cognitive and metacognitive learning activities than the non-awareness group. By contrast, the non-awareness group presented a higher number of affective activities than the awareness group. In order to study if there were statistical differences between the awareness and non-awareness groups in relation to their individual score - indicating for each student the proportion of cognitive, metacognitive and affective learning activities developed during the project- we ran the Mann-Whitney independent non-parametric test (95% significance level) of the SPSS software. This test revealed that the mean values were statistically different in awareness and non-awareness groups in affective units (p=0.037)] and nearly statistically significant in metacognitive units (p=0 .051) while cognitive units (p= 0.328) were statistically irrelevant. Figure 7 represents the mean value of the dependent variable, i.e. individual score of the proportion of cognitive, metacognitive and affective learning activities.

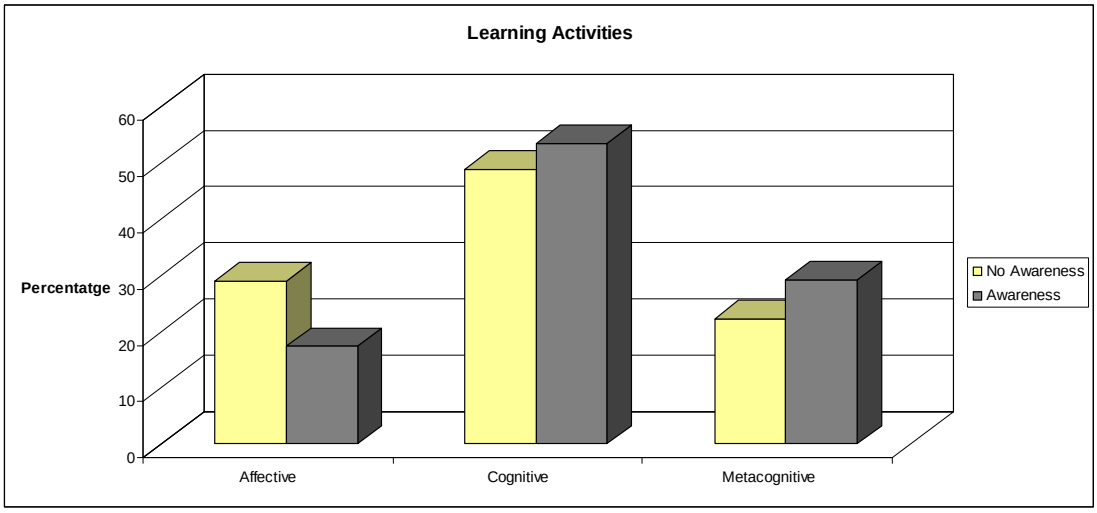

Figure 7. Mean value on the Individual score of the proportion of cognitive, metacognitive and affective learning activities in students' notes.

A detailed analysis of the cognitive learning activities developed by both groups of students showed that awareness group students showed a higher number of subcategories than non-awareness group, especially when discussing ideas and linking internal information. However, such differences were not statistically relevant (Figure 8).

With regard to the detailed analysis of the metacognitive activities, the data revealed that the awareness group students developed a higher number of subcategories namely those related to planning and keeping clarity (Figure 8). The Mann-Whitney independent non-parametric test revealed that the differences between both groups in the subcategories included in the metacognitive category were statistically relevant (planning; p= 0.02; keeping clarity; p= 0.028).

The data of subcategories included in the affective activities revealed that the non-awareness group showed a higher number of subcategories than the awareness group specially those subcategories related to general reaction and chatting (Figure 8). The Mann-Whitney independent non-parametric test revealed that only the differences between both groups in the chatting subcategory was statistically relevant (p=0.48).

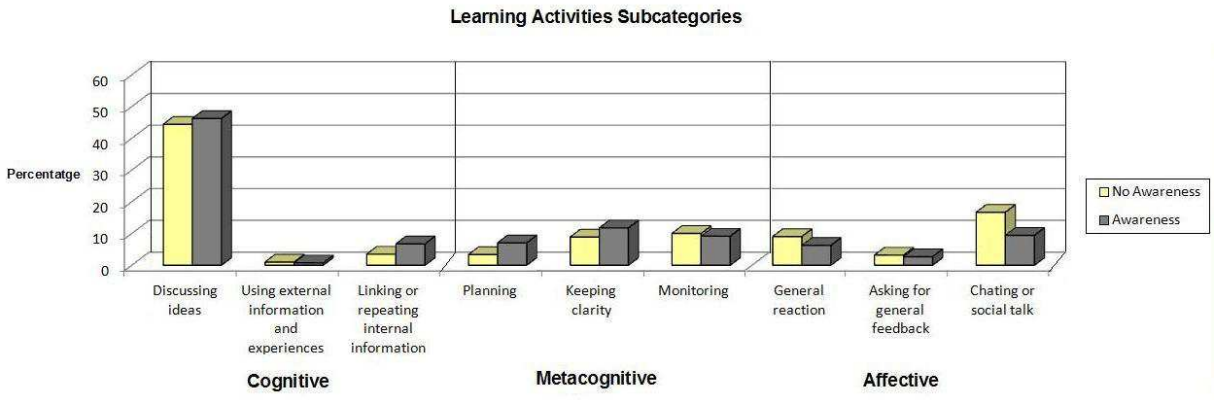

Figure 8. Mean value on the individual score of the proportion of the subcategories of cognitive, metacognitive and affective learning activities in students' notes.

6.4. The use of awareness tools in KnowCat enhances better task performance compared with the use of the system without awareness tools.

We analysed how the group awareness information might improve the students' performance. To this end, the quality of the individual re-written report submitted to the system by each student was evaluated (phase 1- Figure 5). The Mann-Whitney independent non-parametric test revealed that the difference between the mean values of the quality of individual reports was statistically significant; awareness students solved tasks better (non-awareness group: N=23, M=5.83, SD= 1.78; awareness group: N=22, M=8.19, SD=1.25; p=0.006). In this analysis, two awareness group students did not finally submit the re-written reports despite having participated in the annotation process.

7. Discussion and conclusions

Students' perception about KnowCat group awareness information

Students reported that the information provided by the KnowCat group awareness tools increased the students' participation in online collaboration. These results coincide with previous research studies confirming that individuals orientate their own behaviour toward that of the other members of the group (Cobos, Claros & Moreno, 2009; Janssen et al., 2011; Kimmerle & Cress, 2009). The results also confirm that the behavioural awareness provided by the KnowCat awareness tool of P*articipation View* and H*istory View*, which indicates the classmates' participation in the collaborative knowledge area had a positive impact on the students' behaviour. This, in turn, results in active and equal participation of the students to solve a collaborative task.

In addition, the KnowCat group awareness tools create opportunities for social comparison. Thus, the students pointed out that the KnowCat awareness tools they most

frequently used were *Participation view*, *History view* and *Notes view* (Figure 6). This means that, by comparing themselves to other group members, students were motivated to set themselves higher standards for collaborative task resolution. This confirms previous research on the positive effect of promoting social comparison by providing group awareness information. This results in increased students' motivation in the resolution of collaborative tasks and in higher participation rates (Michinov & Primois, 2005; Zumbach, Reimann & Koch, 2006).

KnowCat group awareness information and the promotion of students' feedback

The results obtained in our research showed that the awareness group presented higher participation rates than the non-awareness group by posting a higher number of annotations on classmates' reports. In our work, the pedagogical use of KnowCat notes enhanced the use of KnowCat notes as a tool to give explicit peer assistance in task resolution. Therefore, we can claim that the awareness information helped to better promote the students' involvement in a shared task in which explicit peer assistance emerged. These results coincide with those obtained in previous research studies concluding that awareness information has a positive effect on students' collaborative behaviour and motivation (Janssen, Erkens & Kirschner, 2011).

KnowCat group awareness information and the promotion of collaborative learning activities

Students' higher participation of awareness group was aimed at cognitive and metacognitive actions to solve a collaborative task better. It can also be claimed that the behavioural group awareness tools implemented in KnowCat helped students change their collaborative behaviour in favour of metacognitive processes.

Cognitive activities have been described in educational literature as the thinking processes to learn content and to attain learning goals (Vermunt, 1998). In this study, the term cognitive category alluded to a series of processes related with managing and supplying information about the topic documents written by students. Accordingly, meaning units coded under this category were strongly task-oriented. One explanation for the fact that cognitive activities were the most frequent learning activity in both experimental groups could be found in the design of the collaborative task. Students were asked to help their group mates to re-write and improve their documents about a problem-based activity which in turn referred to a specific course topic. It seemed logical then that the students' contributions revolved around discussing ideas, contributing, referring or repeating internal information about the content of a problem.

Nevertheless, it is group awareness information that has a higher impact on metacognitive learning activities. Group awareness students were aware of the impact of planning skills. Furthermore, students regulated their peers' problem-solving processes either by providing alternative procedures or solutions or by reflecting on how to solve the task more effectively, which approach or procedure was the best one to accomplish the task more effectively.

Another relevant result is the tendency of awareness group students to be more active in monitoring their understanding and strategy use by asking questions -keeping clarity subcategory. Previous research had shown how asking each other questions about the task-resolution processes and self-questioning constitute successful scaffolds in promoting the development of metacognitive skills (Kramarski and Gutman, 2005).

Research on metacognition has emphasised the view of metacognition as an essential part of socially shared discussions. It proves that the others (both adults and peers) play a major role in recent research on metacognition seen as part of a collaborative learning situation where metacognition regulation is also considered as a group level activity rather than an individual's performance (Goos, Gailbraith & Renshaw, 2002; Zimmerman, 2000). From this perspective, the social context that supports and frames the learning task becomes a core mechanism to understand the development of students' self-regulation processes related to task definition, goal setting, planning, enacting and evaluation (Hadwin, Wozney & Pontin, 2005).

The small-scale research project reported here provides some evidences that awareness tools in KnowCat can make a difference in the social and learning context that supports students' collaborative behaviour. This behaviour promotes responsibility and awareness of the processes involved in regulating learning and tasks and in promoting the use of scaffolds. These findings coincide with those obtained in prior studies concluding that awareness group information promoted regulation of mutual performance, co-reflection on cognitive performance, setting goals and formulating plans to enhance group performance cognitive performance (Dehler et al., 2011; Fransen, Kirschner & Erkens, 2011; Phielix et al, 2011).

However, in our study group awareness information did not stimulate social awareness. The awareness group showed a lower percentage of affective learning processes compared with that of the non-awareness group. This result can be justified in that the instructional use of KnowCat was mainly task-related whereas the information provided in the different KnowCat group awareness tools was knowledge-related. Accordingly, students were probably more focused on the cognitive and metacognitive aspects of their collaborative work rather than on the social aspects of their collaboration. Also, the collaborative task was part of a regular university

course, while research in higher education has reported that learning teams in higher education tend to be pragmatic by focussing primarily on task aspects of performance and less on team aspects (Fransen et al., 2011).

On the other hand, it can be argued that the social presence awareness information provided by KnowCat awareness tools –such as On-line Users or Radar View- was sufficient to make all members of the small group feel like a learning community which gave them sufficient and accurate feedback to better solve the task. Nevertheless, we agree with previous research studies that emphasize the role of social awareness in promoting better group processes and performance. This aspect will be further pursued in our research agenda as we believe the social awareness tools in KnowCat could be better developed.

KnowCat group awareness information and students' performance

It can be noticed that group awareness information had a positive impact on task performance. These results outline an encouraging path in the field of CSCL because, in contrast to other previous studies, in our research, the instructional use of KnowCat with group awareness information helped students to solve the task better if compared with the use of KnowCat without group awareness information (Dehler et al, 2011; Jansen et al., 2011). However, these results must be interpreted carefully as the sample size of the population considered in this study might be too limited to extend the results to a wider segment of population.

Furthermore, it should be noted that the nature of the collaborative instructional design used in this study may have had an influence on our results. There are three characteristics of the instructional use of KnowCat that might have increased the potentialities and the impact of group awareness information on collaborative activities and performance. First, the CSCL environment

was used in a long-term instructional process –one semester; this extended time period might have been long enough for establishing a common shared area. Second, students worked at two levels of collaboration: small-group and class-group collaboration; the former enhanced collaboration and increased participation and the latter, based on the KnowCat voting system and the innovative "Knowledge Crystallisation" mechanism of KnowCat, enhanced collaborative decision-making about the best solution to a real case in the community's opinion. Third, the external guidance of course instructors during the process may have also contributed to developing collaboration activities. Instructors developed two key guidance actions: on the one hand, they supplied information to students, at the beginning of the study, on the collaborative purpose of the tasks. This coaching highlighted the importance of scaffolding group partners during the learning processes to solve tasks better by means of joint and group effort; on the other hand, the instructors set the milestones to be accomplished through group collaboration. The impact of the instructors' external guidance on the students' collaborative tasks might have been increased in awareness group students because the milestones to accomplish by the group were registered in the awareness tools provided in KnowCat –History View. Students were given graphical information comparing how the group was actually contributing and how it should have been contributing; this information stimulated the monitoring of the students' collaborative behaviour.

Unsolved questions and further research

Nevertheless, some questions about group awareness tools and their impact on collaborative learning activities and outcomes still remain unanswered in our study. Firstly, our study aimed to examine how the integration of different awareness tools in KnowCat increased their potential for collaborative learning. However, we ignore which of the incorporated

awareness tools had a bigger impact on the students' collaborative processes and task performance. The students' responses to the questionnaire survey gave only general information about their increased perception of the meaningfulness of *Notes View*, *History View* and *Participation View* as more useful awareness tools. Further research should be done to verify how and to what an extent each individual awareness tool can provide valuable information for enhancing effective collaboration.

Secondly, our study only partially analysed how the students' use of a specific awareness tool had an influence on their collaboration. Our study displayed different types of awareness information and revealed to what an extent students used it. However, no effort was invested on promoting reflection and co-reflection from this information. Providing group members with information on their cognitive and social behaviour is not enough to positively alter their behaviour. Group members also need to process this information and ask themselves whether they understand, accept, and agree with the feed-back (Phielix et al, 2011).

In view of this, our next logical step on this line of research may probably focus on studying how students interpret and re-use the awareness information given. To this end, it will probably be necessary to do further analyses on how learners perceive process, interpret and use group awareness information. This future research will probably make use of qualitative methods such as *key event recall interviews* in which students can explicitly explain such aspects as: whether or not they understood the tool, how they valued the tool, their motives for using the tool, their interpretation of the information given, how they used the awareness information to improve collaboration (Beers, Boshuizen, Kirschner, Gjselaers & Westendorp, 2008).

Thirdly, our study showed that providing awareness tools had a positive impact on the students' task performance. However, the sample size considered in this study is too small to allow us to draw a more general conclusion. A larger sample size should be considered to obtain further data that can confirm or dismiss this, so far, encouraging positive effect on learning.

Fourthly, we agree with Phielix et al (2011) that most CSCL environments –as KnowCat – focus on supporting cognitive or task-related processes and provide few possibilities to exchange socio-emotional or affective information through other channels of communication rather than text that might better enhance to form, build and maintain crucial social relationships for collaborative learning.

With a view to strengthening social group awareness, research is currently being done on designing and experimenting with three new awareness tools in KnowCat: a) a *Chat Service*, which will allow users to exchange comments with an online community; b) a *Community Wall Service*, which will allow users to share, by means of posts, their own ideas and concerns in a common shared area (this service was inspired by the Facebook wall posts mechanism, http://en.wikipedia.org/wiki/Facebook_features). It is expected that these two new tools will promote, among KnowCat users, a better and easier way to communicate and interact with other members of a community, a need indicated by awareness group students; and c) the *Motivation Booster*, which provides users with feedback information about the progress of their contributions in KnowCat comparing them against the milestones agreed on by the community and gives some recommendations about how users can improve and adjust their behaviour to achieve efficient collaboration. The main aim of this service is to motivate students to work regularly with the KnowCat platform through motivational messages (recommendation and congratulation messages).

Besides, the *Motivation Booster* provides the instructors with a valuable synthesis report of updated students' work in KnowCat. Thus, the instructor can examine possible students' difficulties to reach collaborative objectives and decide if s/he has to intervene in the community in adjusting common learning objectives. In addition, the instructor can decide if s/he has to help individual students to better contribute to the community.

To sum up, the awareness information helped students orientate, monitor and regulate their collaborative processes. Our future research will focus on applying this exploratory result on a larger study group and assessing fully the students' work using the KnowCat system and, also, employing qualitative methods to verify how the use of awareness information improved their collaborative processes and group performance.

8. Acknowledgment

This research was partly funded by the Spanish National Plan of R+D, project numbers: EDU2009-11656, EDU2012-32415, TIN2011-24139; and by the CAM (Autonomous Community of Madrid), project number S2009/TIC-1650.

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Appendix 1: Coding Scheme.

CATEGORIES	SUB-CATEGORIES	Subcategory description	Subcategory example
Cognitive activities	Discussing ideas	Students raise a problem, reason out a solution; make an evaluation of an idea contained in the work of a classmate. Students contribute to create a shared understanding of the problem	-I agree that there are aspects that relate to the contents of the subject article... -I liked the use of conceptual maps and tables to make understandable the main concepts of the article. -I think that your conclusions are good and clear.
	Using external information and experiences	Students contribute with new information sources outside the speech-based or with related and relevant experiences.	-… To do that, you can rely on the theoretical framework presented in the document of our colleague John. -I think that you should cite *Shuell (1996*) in his introduction about…
	Linking or repeating internal information	Students repeat or link ideas already contained in the dialogue.	-You considered necessary aspects of the practice and the evaluation of... -The use of oral language is very important to reach a consensus among the different members of the group, as dialogic language is a mediator.
Metacognitive activities	Planning	Students present or ask for an approach or procedure to carry out the task.	-You should add a scheme with information on the following points... -You could divide your explanation in different sections to improve the presentation of your ideas.
	Keeping clarity	Students ask for an explanation, synthesis of information, clarification, or illustration.	-You say that to carry out this experiment in Primary Education more teachers would be required. Do you think that this is the only point to keep in mind? -Could you provide examples?
	Monitoring	Students remember the original planning or aim. The students mention the work done by their classmates and suggest ways of improving on it.	-You've taken a good scheme, but you could improve your contribution if you add another column in which you tackle on... -If you worked in Secondary Education, what ideas of this article would you use?
Affective activities	General reaction	Students emotionally react towards their classmates' work and give a positive general opinion.	-First of all, congratulations on your work. -Good job!
	Asking for general feedback	Students ask for general impressions or views to their classmates.	-Do you think that I propose adequate recommendations? -What would you do in my shoes? - Let me know what do you think about my new ideas?
	Chatting or social talk	Students make notes of an informal or social nature to develop positive affective relationships, group cohesiveness and trust.	-Hi, how are you? -Don't lose heart! -Nothing more, it continues as well!

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