Supporting Knowledge Negotiation in Virtual Classrooms

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ABSTRACT

Negotiation is an essential component of collaboration: By means of knowledge negotiation, a group of knowledge workers or collaborative learners determines what knowledge they have constructed together and accepted as a group. We develop the concept of "knowledge negotiation" as an important aspect of knowledge building and knowledge management, and then adapt CSCW support for negotiation to CSCL by critiquing previous work and extending the BSCW system to promote collaborative learning among students. An appropriate conception of knowledge negotiation is discussed and a corresponding software support mechanism is described within a new system being studied in schools in several European countries.

Keywords

knowledge negotiation, negotiation, CSCL, collaborative learning, educational software design, co-construction, perspectives, knowledge building, knowledge management

THE CSCL CONTEXT

Negotiation is a central phenomenon in cooperative work and collaborative learning – specifically the negotiation of what is to count as new shared knowledge. While there has been considerable research on computer-supported collaborative learning (CSCL) lately, this has not been accompanied by discussion of computer software mechanisms to support negotiation within learning contexts.

Consideration of computer support for negotiation has arisen in the past primarily in relation to group decision-support systems (GDSS) for use in industry [8; 17]. GDSS is a sub-area of computer-supported cooperative work (CSCW). Although CSCW is a sister field to CSCL, its decision support, knowledge management and social awareness mechanisms have not yet been adapted for CSCL applications. This paper provides an example of how one can adapt a CSCW approach to a CSCL context by re-thinking the nature of the interactions within these differing contexts.

Starting in May 2001, the European Union ITCOLE Project (Information Technology for COllaborative LEarning and knowledge building) [19] began to develop and test a new software system for K-12 classroom support named BSCL (Basic Support for Collaborative Learning). Developers in Finland, Germany and Spain are working together to design and implement BSCL.

BSCL is an adaptation and extension of the well-known and widely used BSCW system [1; 2; 16]. Used by over 200,000 people since 1995 when it was developed at the Institute for Applied Information Technology – FIT (previously a GMD Institute, now a Fraunhofer Institute near Bonn, Germany), BSCW provides a system of autonomously managed Web-based workspaces that can be used by members of a workgroup to organize and coordinate their work. These workspaces are central access points for shared documents, including folders for organizing them and a wealth of functionality for knowledge management.

In BSCL, new components have been added to BSCW to offer improved support for knowledge building (usually created in threaded discussions), social awareness (knowing who else is active in the system) and synchronous interaction (multi-user diagramming with chat). An initial version of BSCL has been successfully field-tested by pedagogic researchers, teachers and students in Greece, Italy, the Netherlands and Finland. The system is fully multi-lingual so that students in different countries view the user interface in their native language. Development and dissemination of a revised version is currently underway; a major new feature is the support for negotiation described in this paper. A future round of field tests will include cross-cultural courses in which students from more than one country collaborate together at a geographic and cultural distance by means of BSCL.

The question we recently faced as designers of BSCL was how to support negotiation among students. Collaborative learning in classrooms has different requirements for sharing knowledge than what is supported by BSCW for professional teams. For one thing, BSCW is used primarily for knowledge management – the sharing and manipulation of knowledge that already exists somewhere within the workgroup. BSCL, in contrast, is intended to support knowledge building – the collaborative construction of knowledge that is new within the community.

We began by considering relevant explorations of negotiation in CSCW. Then we reflected on the role of negotiation in collaborative learning, based on the major

theoretical frameworks for CSCL. From this, we identified various conceptualizations of negotiation associated with alternative possible support mechanisms. We developed a concept of "knowledge negotiation" that seemed most suited for BSCL scenarios. This notion may be relevant for many CSCW contexts as well. We implemented support for knowledge negotiation among students in small workgroups, and are now studying the effects of this support in European classrooms.

NEGOTIATION IN CSCW

Negotiation is a process by which a group of people who are working together arrive at a group decision. The approach to conceptualizing and supporting this process has been rather limited within CSCW.

Negotiating as voting

Within traditions of computer science (or informatics), it is common to model negotiation as a voting process. This is not only a result of the implicit acceptance of rationalist philosophy and communication theory as information processing, but arises also for pragmatic implementation reasons:

1. Rationalism assumes that people have ideas already existing in their heads – in the form of expressible propositions, mental representations or brain states – that they can then express verbally as opinions on the basis of which they may vote on various issues posed to them [41].
2. Communication theory in the information processing tradition [25] builds on the rationalist model and construes communication as the transfer of such pre-existing opinions (as data) through (error-prone) media.
3. Implementation of computer support tends to accept these models because computers necessarily represent explicit information, such as propositional representations of explicit opinions [26]. They can easily respond to small numbers of clearly pre-defined options, such as yes/no votes.

Thus, when we look for examples of support for negotiation in CSCW, we find that they generally reduce negotiation processes to voting processes, assuming that the goal is to collect and respond appropriately to a set of opinions that already exist in the minds of the individual system users. In particular, this is true of GDSS systems that typically include a component for conducting straw votes [8; 17]. Straw votes, by definition, are a means of measuring pre-existing personal opinions, with no attempt to influence them or to build group consensus.

Negotiation as approval of decisions

Herrmann [35] has proposed a notion of negotiation that goes significantly beyond the simple voting model. He and his students have developed an approach to computer-supported negotiation over the years, and have designed and/or prototyped it in a number of software systems [11; 12; 13], including a simulation of negotiation [20]. He has reviewed related CSCW research and has developed a socio-technical model for his approach to negotiation. His examples involve group decisions for knowledge management, such as what categories should be used in a shared bibliography or what category should be applied to an entry in a shared bibliography.

In Herrmann's approach, someone makes a proposal and the other group members can vote on the proposal. They always have an opportunity to comment on their vote. In addition, they can make a counter-proposal or call for discussion outside of the computer support system. Although this approach goes beyond a simple yes/no voting system with options for counter-proposals and for switching communication media, it is still based on a model of negotiation as voting. This approach serves well to conduct a straw vote to see where agreement does or does not already exist, but cannot well support re-framing or co-construction of knowledge. It recognizes the frequent need for people to engage in more complex processes of interaction to settle a negotiation issue and allows for people to leave the computer support system to do this, but provides little automated support for their consequent decisions to affect the knowledge in the system.

Negotiation as access permission

Wulf [38; 42; 43] has proposed further extensions of the voting model, now applied to access rights rather than decisions. His examples include the right of an individual to access a specific document created by another member of the group. The empirical cases he cites from governmental bureaucracies might best be considered examples of moderated, rather than negotiated, access. The primary actors do not engage in negotiation with one another, but agree to have their interactions mediated by trusted third parties or public procedures, including automated procedures in a computer support system.

Applied to CSCW systems, the issue is whether a particular user should have access to a specific system function, such as editing a document. Wulf has developed a formal Petri net model of negotiation approaches, but oriented to the question of access. This paradigm may work for situations with fixed options, such as access to a defined system function, but not in the general situation in which a group is collaborating to produce group knowledge through exploration and inquiry.

Negotiation as intertwining of perspectives

Individual learning, as a process of constructing personal knowledge, takes place within a learner's personal perspective [27]. Collaborative learning involves an interaction among perspectives contributed by the participants and a merging of these into a group perspective definitive of the group discourse. There have been scattered attempts to formulate a conceptualization of perspectives that would lend itself to computer support [6; 22]. The `Phidias` system was an early attempt to display a

database of design rationale notes according to different "contexts" [21]; this was subsequently re-implemented in Hermes, where shared contents were displayed within different professional or personal perspectives [26].

Stahl and Herrmann [35; 36] proposed an approach to integrating Herrmann's negotiation and Stahl's perspective mechanisms within a single software system, WebGuide, that they designed specifically to explore these mechanisms. The motivation for this was the following: On the one hand, negotiation takes time, and group members may want to continue working on a topic while it is under negotiation – perspectives allows them to continue to work in their own perspective while contents of a group perspective are being negotiated. On the other hand, within individual perspectives there is a strong tendency for ideas to diverge [14] – negotiation is required to bring ideas back into consensus and to promote individual ideas to the status of group knowledge. So it seemed that integrating perspective and negotiation mechanisms – and conceptualizing negotiation as the intertwining of multiple personal perspectives to arrive at a shared perspective – would mutually solve the two central problems of these mechanisms.

While the perspectives mechanism has by now been extensively implemented in WebGuide [33], the corresponding negotiation mechanism is still missing in that system. The lack of an appropriate negotiation mechanism was already reported as a serious limitation of WebGuide at the 1999 CSCL, Group and WebNet conferences [28; 29; 36]. The delay in implementing negotiation support in WebGuide was largely a result of the feeling that the voting model of negotiation did not seem appropriate for CSCL uses of groupware. Recent reflections on the relation of perspectives to knowledge building [34] suggest that a different, more dialogical, concept of negotiation is called for.

NEGOTIATION IN CSCL

To appreciate the role of negotiation in CSCL, consider the centrality of negotiation within each of the different theoretical frameworks that have historically dominated this field:

Small group process

The fore-runner of CSCL was an approach to group learning that focuses on small group process and argues that participation in group processes tends to improve the individual learning accomplished by the participants [32]. This approach maintains a traditional view of learning as transfer of information from teacher to students, and conducts experiments to demonstrate the increase in individual learning outcomes through group work in classrooms. These experiments were conducted before computers started to be used in schools. A typical approach would be to divide up topics within a course and assign the topics to small groups; the small groups would *negotiate* agreed upon solutions to their topic; the different groups would then share their solutions with the larger group, for instance using procedures like "jig-sawing" [7]. The research focus is on small-group processes like conflict resolution and negotiation.

Constructivism

Based on the theories of Piaget and Vygotsky on child development and learning, the constructivist approach emphasizes that knowledge is constructed and that children must each construct their own understanding based on what they are already capable of understanding. Within this approach, it is possible to focus on the individual child as the unit of analysis to see how the individual constructs knowledge and, potentially, how this construction can be supported with computer software [23]. Alternatively, one can focus on the small group as the unit of analysis within which knowledge is socially co-constructed [40] before it may be internalized by individuals. This social co-construction can be conceptualized as a *negotiation* process by which shared understanding is reached by a group through interactions within the group. The goal of negotiation is to construct a "knowledge object" or knowledge "artifact" [5; 34].

Distance education

With the advent of the Internet, technical possibilities significantly expanded for conducting education where the teacher and students are not necessarily co-present. Again, distance education can be analyzed on an individual or group level. Technology can be seen as a means for transferring information to distant individuals or as a communication medium through which groups can interact, collaborate and *negotiate*. While static websites can be used to disseminate information to individuals, interactive cooperation support systems like BSCW provide the capability of facilitating collaboration at a distance. However, even when interaction is possible, for instance with threaded discussion in asynchronous conferencing systems, it is hard to encourage sustained, in-depth knowledge building; discussions tend to diverge without some form of *negotiation* to bring different people's ideas back together [29].

Distributed problem-based learning

A good example of a pedagogical approach that combines computer support for both small groups and their individual members is distributed problem-based learning (dPBL). Originally developed for medical education, PBL is built around problem cases, like patients presenting illness symptoms that a group of about five students and a tutor attempt to diagnose. The group *negotiates* lists of problem statements, key evidences, working hypotheses and learning issues. Then the individual students research relevant medical theories and come back to the group to *renegotiate* the group understanding. The tutor plays a key role in guiding the negotiation process [4]; this guidance role is gradually internalized and taken over by the students. Attempts to provide computer support for dPBL –

such as [37] – need to develop negotiation support mechanisms.

Distributed cognition

Recent developments in social, cognitive, communication and pedagogical theory have increasingly stressed the group as an important unit of analysis for understanding the creation and dissemination of knowledge. Theories of distributed cognition argue that knowledge is not simply a matter of an individual's mental representations (as emphasized by cognitive theory and artificial intelligence in past decades), but is frequently distributed among the abilities of group members and the artifacts that they use [15]. Accordingly, knowledge is co-constructed by interactions among people and their shared artifacts, including prominently by means of *negotiation* practices that result in establishing a common ground for understanding.

Situated learning

This theoretical approach focuses on a larger group level, the community of practice [18]. It views learning in terms of changing relations within the community – e.g., that someone becomes a more central player within the community and even changes the way the community functions. Like situated action theory [39] and ethnomethodology [10], the situated learning approach looks at how people skillfully interact socially to co-construct and interactively *negotiate* knowledge, rather than at individuals as possessors of explicit propositional knowledge.

Cultural-historical activity theory (CHAT)

The social reading of Vygotsky is pushed hardest by CHAT. Here, learning is viewed as it takes place over extended periods of time and within its broad cultural and historical contexts. In this way, it is possible to track "expansive learning" in which multiple groups even *negotiate* changes to the existing social arrangements [9]. Here, again, socially shared artifacts play a significant role in providing a focus to negotiations.

It is possible to conceptualize collaborative learning in different ways, focusing on various units of analysis. However, in each approach some form of negotiation plays a central role in the learning process. In order to design computer support for negotiation in collaborative learning, it is necessary to specify an appropriate concept of such negotiation.

CONCEPTS OF NEGOTIATION

The traditional CSCW concept of negotiation as voting seems inadequate for CSCL. In particular, the negotiation of what is to count as new shared knowledge for a group engaged in collaborative knowledge building has different characteristics from other forms of group decision making. Such negotiation might be called "knowledge negotiation" because it is not just a matter of selecting among alternative existing states (propositions, proposals, access functions), but of constructing new knowledge through collaborative interaction and discourse. The new knowledge is typically represented by or embodied in a shared "knowledge artifact," such as a concept, theory or text.

Negotiating as bargaining

Knowledge negotiation is at heart quite different from voting. It is, in its paradigmatic forms, a nuanced give-and-take, whose aim is to reach a solution that did not already exist in any participant's opinion, but that is ultimately made acceptable to all. It often involves compromises, whereby one participant gives way in part to another's wish in order to get the other to give in partially to one's own position. Negotiation is a way people respond to non-routinized, "wicked" or ill-defined problems – where reaching agreement often involves re-framing the issues [24].

Negotiating as discourse

The negotiation process as bargaining is not well modeled as a series of pre-existing positions, among which the group must vote. Nor is it well modeled as a series of positions and counter-positions among which the group must choose. In a negotiation process, typically two or more starting positions interact and evolve through a series of changing alternatives until a single consensus position is reached through discussion. The discussion is a subtle political interaction that brings many aspects of power, motivation and persuasion into play; it is a sophisticated linguistic process that cannot be algorithmically interpreted. In the end, when a consensus is reached (or not), there is often little need for a vote because agreement (or agreement to disagree) has already been established. The purpose of a vote would be to signal within a support system that everyone agreed that a consensus had been reached.

Negotiation as knowledge building

Negotiation may be conceptualized as a much broader phenomenon than the process of making a joint decision about pre-specified actions (or explicit access permissions). Collaborative knowledge building, itself, can be viewed as fundamentally a knowledge negotiation process. Proposed statements of knowledge by individuals are subjected to collaborative interactions, whereby meanings of terms are clarified, alternative related statements are compared, linguistic expressions are refined, warrants are scrutinized, etc. [31].

Through these activities, the original suggestion is transformed; through broadening consensus, the resultant expression increasingly takes on the status of socially established knowledge [34]. Simultaneously, this process establishes a "common ground" of understanding concerning the meaning of the accepted expression and its constituent terms [3]. This does not necessarily mean that every individual involved fully understands and accepts this common ground in his or her own mind, but rather that a group understanding has been established in the discourse

of the community in which this knowledge is thereby accepted [34]. The co-constructed knowledge is embodied in some form of cultural artifact, such as a text or slogan; the common ground provides a basis for the meaning of the artifact (the meaning that the artifact serves to encapsulate) to be understood in a shared way by the collaborative community.

The shift to understanding group interactions in more dialogical terms as co-construction within a discourse community has implications for the design of groupware: away from automated selection among alternatives, toward greater emphasis on supporting communication among system users [30]. Accordingly, it is necessary to design an appropriate mechanism for the support of knowledge negotiation in situations of collaborative learning.

BSCL AS AN EXTENSION OF BSCW

BSCL is an adaptation and extension of the BSCW system for collaborative learning applications in schools. It supports the roles of teachers and students which define the available functionality and access rights that the respective users have. Groups of students are invited by their teachers into courses. The courses are usually split into smaller workgroups (typically comprising about 3 to 7 students) that pursue specific learning goals.

Each student, workgroup and course has an associated "virtual learning place," i.e., a folder in which information and ideas are collected, typically in the form of documents, notes, links to Web pages and discussion threads. Learning places may be hierarchically structured in sub-folders. The default structure of learning places supports the concept of perspectives: There are personal, workgroup and course perspectives for students collaborating in workgroups within larger academic courses (see Figure 1). Teachers and students can use BSCW operations to create other kinds of folder structures, but the structure to support typical workgroup collaborative activities is generated automatically by BSCL as the default.

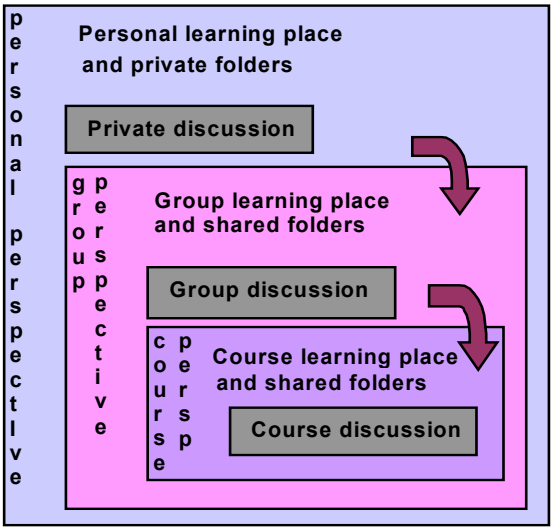

Figure 1. The structure of the personal, group and course learning places in BSCL, with two new operations indicated. Copying between personal and group perspectives is un-constrained (top arrow). Promoting knowledge artifacts from a group perspective to a course learning place is subject to knowledge negotiation procedures.

These virtual learning places support primarily asynchronous modes of collaboration within groups, which may be geographically dispersed, as in distance education applications. In addition, BSCL supports synchronous modes of collaboration by providing a joint whiteboard for creating concept maps and other simple diagrams, and a chat tool for on-line discussions about the diagrams. For structuring discussions the students have to assign so-called thinking types to their contributions by classifying them, e.g., as "problem statement," "working theory," "summary statement," etc. This scaffolds and makes explicit the inquiry process of collaborative knowledge building in BSCL.

BSCW provides a sophisticated set of mechanisms for specifying who is allowed to do what, where, to which objects. By properly defining roles, learning places, objects and menu items, it is possible to implement arbitrary access functions, f (user, object, function, workspace). Of course, this can become a complicated and confusing business, so part of what BSCL does is to establish default roles, objects, menus and workspace structures that are appropriate to typical classroom interactions. A negotiation mechanism is a necessary component of this default structuring in order to support typical classroom knowledge building.

Knowledge Building within BSCL

For the knowledge building process, students typically collect information and ideas for a learning project in their personal or group learning places. They share and discuss these in the group learning place. The essential task of a workgroup is to produce a group report or "knowledge building portfolio" from collected materials and the associated discussions, and place the report and the associated material in the course learning place for students from other groups to view and discuss.

Within an academic setting, such a contribution to the course learning place may count as the group's final product or work portfolio, displayed as the group's knowledge, shared with the other course members so they can learn from it and comment on it. It may also be evaluated by the teacher or others once it has reached this stage.

In BSCW, any user would be able to copy objects from a group to a course learning place. Because of the requirements of the school setting, it is important that a workgroup has reached a consensus on what may count as (and be evaluated as) their group product. This requires a negotiation function.

In a CSCW system, access rights and access functions may be specified to an arbitrary degree of precision. This determines whether a given user can execute a given operation under various conditions – or in BSCW, whether the operation even appears on that user's menus. The rules governing access may even be adaptable so that a group or manager can adjust these rules. However, once set, the rules arbitrate group conflicts silently and invisibly. For instance, if one member of a group workspace wants to delete or edit a document and another member does not want this to happen, then the rules determine whether it can be done or not – but the conflict between the members who do and do not want the operation to be executed is never made apparent. In a given case, no one knows who favors what or if and when there is a conflict of desires, let alone people's reasons. The systems of Herrmann and Wulf have the advantage of making such conflicts visible and providing means for resolving them interactively.

In Figure 1, transitions of knowledge from the personal perspective to the group perspective and from there to the course perspective are indicated with arrows. The first transition can be carried out at any time by someone from their personal perspective. This is an access rule based on the principle that anyone can do what they want within their own personal perspective and that the purpose of the group perspective is to provide a place for group members to propose and discuss whatever they choose to. The other transition is where the knowledge negotiation mechanism under discussion comes into play. Here we want to bring to light any conflict within the group about promoting a knowledge artifact to the class perspective as a product of the group. Access to this operation in BSCL needs to be mediated by an explicit negotiation process.

Approach to knowledge negotiation in BSCL

The discussion process within a workgroup may already be considered as an implicit knowledge negotiation process. However, in the BSCL system we make this process fully explicit to the users by commencing a formal negation when a member of a workgroup proposes to promote a group knowledge artifact to the corresponding course perspective.

Operationally, the difference between the CSCL knowledge negotiation that is proposed here and the CSCW voting approach is that the real negotiation action is in the evolution of the knowledge artifact proposed for agreement, and not in the voting process itself. What is needed is to allow a proposed knowledge artifact to be successively changed by the negotiating parties until all (or a substantial majority) of them agree that the object is now an acceptable representation of the group knowledge. This knowledge negotiation process may proceed as follows:

1. A member of the group proposes that a specific knowledge artifact (a folder, document, single idea, or threaded discussion) be promoted to the course perspective. Criteria for the acceptance of the proposal, (e.g., a quorum of 75% positive votes from the group members within a week) has generally already been set by the teacher for the whole class.
2. The knowledge artifact is made available for all group members to modify – i.e., the object proposed for negotiation has group access rights – within a negotiation interface at the group perspective level.
3. A threaded discussion area is made available for the group members to negotiate changes to the artifact, including the statement of reasons and suggestions for acceptable modifications.
4. At any point, a member can vote to accept the artifact in its current state. These votes can be withdrawn at any time, e.g., when a group member has made a counter-proposal which is considered more appropriate.
5. When the preset criteria for acceptance are met, the artifact is automatically promoted (copied) to the class learning place. There is a time limit for group approval; however, this is often moot since the group is usually strongly motivated to agree on final knowledge products in order to produce their portfolio and complete their work assignment.

In this approach, the voting interface can be extremely simple – for instance a button for the current user to signify "yes" for the current version of the proposed artifact. The important point for the knowledge negotiation process is the possibility for a participant to state his or her reasons for withholding agreement in terms of dissatisfaction with the current state of the knowledge artifact. Thus, an adequate interface for the negotiation dialog is needed, in which students can formulate their disagreements so that the knowledge artifact can be modified in a direction that is likely to promote consensus. The knowledge negotiation interface therefore includes its own threaded discussion. At the conclusion of negotiation, this threaded discussion represents the history of negotiation and implicitly reflects changes that have been made to the knowledge artifact as part of the knowledge negotiation.

SUPPORT FOR KNOWLEDGE NEGOTIATION IN BSCL

The following three operations are provided in BSCL for the promotion of items from a group learning place to its course learning place: (a) "propose for copying to course perspective," (b) "copy to course by teacher" and (c) "define negotiation parameters." (The implementation of these operations may be revised based on the experiences from the field tests.)

Figures 2, 3 and 4 illustrate the group, negotiation and course learning places at different points of the knowledge negotiation process.

(a) Proposal for copying to course perspective

This operation initiates negotiation among students in a group about what content to copy to the course level. It involves the following conditions and actions:

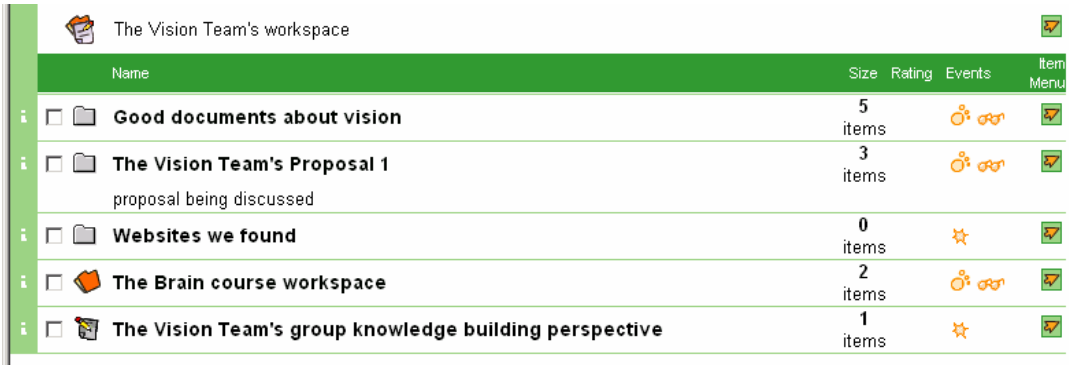

Figure 2. The group learning place with a proposal under negotiation. Here, a workgroup named "the Vision Team" has collaboratively collected and discussed documents and websites about vision. At least one member has proposed promoting a selection of these documents to the course perspective for broader dissemination and discussion. This has created a folder entitled "The Vision Team's Proposal 1" (see Figure 3).

Figure 3. The proposal folder. The sub-folder with documents is the knowledge artifact being negotiated. Within the proposal folder are: this artifact, a proposal object that keeps track of the level of agreement about this artifact, and a threaded knowledge building area for discussing changes that should be made to the artifact in order to establish consensus about it as a product representing the work of the group.

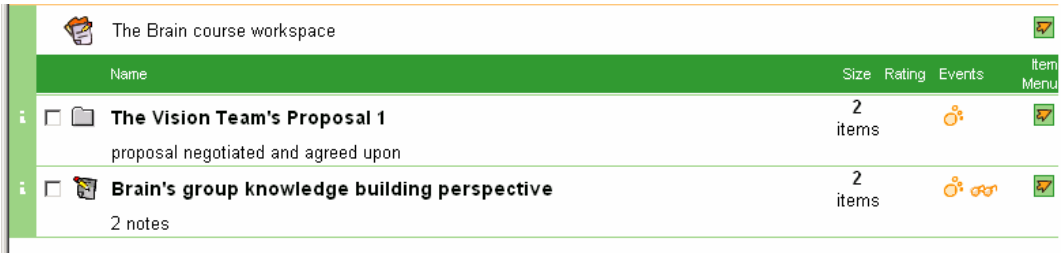

Figure 4. The course learning place with the agreed upon result of the group's collaboration, after agreement has been reached and the knowledge artifact has been promoted to the course learning place. Now course members can all start to discuss this contribution by the Vision Team to course knowledge about various aspects of the brain.

1. This operation must be executed within a group learning place.
2. This operation may be activated by any student or teacher who is a member of the group.
3. One or more items in the group learning place must have first been selected.
4. A proposal folder is created in the group learning place, with the name "group's proposal" and the message "proposal now being discussed."
5. Copies of the selected items from the group learning place are placed in the proposal folder.
6. A threaded discussion area is created in the proposal folder with the name "proposal negotiation."
7. A voting object is created in the proposal folder with the name "now I approve the proposal" and a statement of the current negotiation status, such as "approved by 3 of 6; still requires 2 by October 14."
8. Whenever a vote is submitted, the description of the voting object is re-computed.

9. When the specified majority has approved the proposal, the voting object is deleted and the content of the proposal folder (the proposal contents and the threaded discussion subfolder) is frozen so that no one can modify it.
10. A copy of the frozen proposal folder is placed in the course learning place on behalf of the group. This is the primary way for items to be created in a course learning place. The students typically have read-only permission in these folders.

(b) Copy to course by teacher

This operation allows a teacher in a group to copy contents of the group perspective to the larger course perspective. (This by-passes the usual negotiation process within the workgroup but we believe that this should be a pedagogical option for a teacher.) The operation involves the following:

1. This operation must be executed within a group learning place.
2. This operation may be activated by a teacher who is a member of the group.
3. One or more items in the group learning place must be selected.
4. A proposal folder is created in the group learning place, with the name "group's proposal" and the description "copied by teacher."
5. Copies of the selected items from the group learning place are put in the proposal folder.
6. The content of the proposal folder (the proposal contents) is frozen so that no one can modify it.
7. A copy of the frozen proposal folder is placed in the course learning place.

(c) Define negotiation parameters

This operation allows a teacher to redefine the parameters for negotiations by groups in a course. It consists of the following:

1. This operation must be executed within a course learning place.
2. This operation may be activated by a teacher who is a member of the course.
3. The following parameters may be reset: percentage of student members who must approve a proposal and the deadline (date or number of minutes/hours/days allowed) for the negotiation.

STUDYING NEGOTIATION IN CLASSROOMS

Knowledge negotiation is a central process within collaborative learning. However, most software systems for learning do not support it explicitly and adequately. As described above, negotiation support functionality has now been implemented for a revised version of BSCL, to be tested in 50 schools in Greece, Italy, the Netherlands and Finland as part of the field trials of BSCL within the ITCOLE project.

We are especially interested in collecting and analyzing empirical data on knowledge negotiation using BSCL. The current design of support is based on our experience with the use of BSCW under many conditions during the past seven years [1; 2; 16], with studies of prototype systems by Herrmann and his students [11; 12; 13; 20], and with systems created by Stahl and his associates [27; 28; 29], including the joint exploration of perspectives by Herrmann and Stahl [35; 36]. BSCL itself is now being used in a variety of European schools.

The BSCL system has been instrumented to log all knowledge building and knowledge negotiation activities so that the mechanisms described here can be evaluated in detail. In particular, every time a menu item is executed, the specifics of the action are saved to a server log that can be analyzed in a spreadsheet or with special analysis tools. All threaded knowledge building areas, including those within negotiation folders, are saved to an electronic file for quantitative analysis; interesting sessions will be printed out for manual qualitative analysis.

Quantitative analyses of timing and depth (e.g., thread lengths) of negotiation discussions will indicate the importance of the knowledge negotiation within the larger knowledge building processes. Qualitative analysis of the discourse in key discussions may provide further insight into the nature of the negotiations conducted.

Clearly, such negotiation processes are extremely sensitive to social settings and age groupings. We will be able to compare student groups across several age levels in K-12 and across contrasting school cultures in northern and southern Europe. We will also run trials at college and workplace settings to broaden the basis of comparison. However, we suspect that detailed analysis of individual case studies – if they are sufficiently rich and if they yield to a combination of quantitative and qualitative analysis – will provide significant insight into the phenomenon of computer-mediated knowledge negotiation.

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