TRES FACIUNT COLLEGIUM – Paderborn's Collaboration Centred Approach for New Forms of Learning

Thorsten Hampel
Computers and Society, Heinz Nixdorf Institut,
Fürstenallee 11, 33102 Paderborn, Germany, E-Mail: hampel@upb.de

Abstract: This paper defines several key requirements for successful cooperative learning, which we have elaborated during the last years with goal to set up new forms of cooperative learning. Without bringing them into a special order, these main design criteria are the integration of synchronous and asynchronous forms of cooperation and the persistence of a learning process, the formation of a common group context or common information room, roles and access rights, annotations and structured chat as well as rooms as places for collaboration.

Key requirements for successful computer supported learning

"My claim is simple: in order to make truly effective groupware, we will need new eyeglasses and methodologies for probing how and why collaborative tools work. Why? After all, isn't our natural tendency to collaborate rather than to work in isolation? Probably yes, but often the more natural something is, the more subtle or unnoticed the mechanisms are which make it fantastic."[1]

Since the beginning of the nineties, in Paderborn, we studied new concepts and solutions to enhance cooperative and active forms of human learning. Spanning from the design of so called learning supportive infrastructures which even includes the set up of learning theatres up to new understandings of human learning the bandwidth of our activities tries to bring new media and cooperative forms of learning into a form of every day viability. Therefore our goal is to develop tools and solutions not only to justify our concept and research goal, but to change our way of learning and teaching with lasting results.

For four years now, the development of our sTeam–"structuring information in a team" approach is in progress.[2] Our idea is to set up an open source project for a framework covering various tools and applications in the field of computer supported cooperative learning. To do so, it is of main importance to develop very detailed concepts and architectures and to get a clear understanding of the functionality and metaphors which might be applied to human forms of cooperative learning. With the aim of achieving a firm understanding of the odds and ends and limitations of computer support in group work, we continuously evaluated and adapted existing solutions out of the field of computer supported cooperative work systems for our particular needs.

Hundreds of software solutions have been developed in the last decades to enhance cooperative work and cooperative learning (for a early overview see (Mandviwalla & Olfman 1994)) but only a few have left the design labs for larger practical use. May be Greenberg is right, stating that the reason might be the concentration of the developers on technical more than on human factors when shaping such systems. "*In summary, groupware for real time collaboration requires careful attention to both technical and human factors. The human factors should drive the design, for there are many requirements and nuances that determine whether a system will support collaboration effectively."*[3]

The following article outlines several main criteria and design goals for our system which might hopefully serve as key requirements for successful computer supported learning and computer mediated communication. Other surely important criteria apply, such as the flexible support of attributes and various document formats, the allowance of user definable server objects and the overall extensibility and scalability of the server. These requirements will not be further discussed in the course of this article.

Here, we will mainly enlighten our theoretical concepts and design goals and not the selected technical architecture or its implementation. First prototypes exist now for three years and have constantly been redesigned. Currently we are in process of doing a complete technological redesign which facilitates the transformation of the whole project into an open source approach. The upper mentioned proceeding provides us with the time and the

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[1] stated by J.S.Brown at the panel titled "breakthroughs for user acceptance", 1988, see Greif, I., Brown, J.S., Dyson, E., Kapor M., Malone, T. (1988). Computer-supported cooperative work: breakthroughs for user acceptance, *Conference proceedings on Human factors in computing systems*, May 15 - 19, 1988, Washington, USA.

[2] see Hampel, Th. & Selke, H. (1999). Customizing the Web – Two Tools for individual and collaborative use of hypermedia course material, Collis, B., Oliver, R.: *Proceedings of ED-MEDIA 99*. Charlottesville (Va.): Association for the Advancement of Computing in Education, 634–639.

[3] see Greenberg, S. (in press). Real Time Distributed Collaboration**.** In Partha Dasgupta and Joseph E. Urban (Eds.) *Encyclopedia of Distributed Computin*g, Kluwer Academic Publishers.

chance to revise and enhance our fundamental conceptual ideas. The following main requirements reflect this process.

Integration of synchronous and asynchronous forms of cooperation – persistence of the learning process

When trying to categorize different computer supported cooperative work environments it is quite important to look both at technical features and at the even more important underlying concepts and metaphors for cooperative learning and working. During the process of the "proofing the concept" of our prototypes for the sTeam approach, we found ourselves confronted with a series of topics which serve as essential pre-conditions for later design of a successful co-operative learning environment.

Learning at university takes place at different locations such as lecture halls, tutorials, the library, at the students` home, but as well in different learning situations, such as face-to-face meetings or synchronous virtual meetings and of course in asynchronous forms of cooperation. To be successful, tools have to support these different ways of working in groups, we call this a mixture between asynchronous and synchronous forms of cooperation. Another elementary factor for the integration of synchronous and asynchronous forms of communication is the persistency of artefacts, such as all forms of electronic documents and objects, during the process of cooperation. Meaning the environment has to provide persistency for all objects created by learners. Thus, as a basis for cognitive learning the learner must be enabled to create, rearrange, structure and transport learning objects. The abilities provided are called the basics functions of media, the media functions. [4]

Closely related to the media functions and an important aspect for a successful working with different media is the reduction of so called discontinuities in the use of electronic media. Discontinuities appear each time a learner has to switch to a different media while transporting information, e.g. they have to make personal (paper based) notes on an electronic presentation held by the lecturer. These discontinuities in the application of media naturally put an end to any consequent use of computer mediated learning supportive infrastructures. Therefore it seems to be fundamental when shaping infrastructures for cooperative structuring and building of knowledge to adapt learning supportive infrastructure to the behaviour of the learner and not the other way around.

A common information room and group context

When discussing basic concepts of cooperative learning it seems to be essential, that learners form a common information room for the group. Ellis defines this common information space as the common group context (Ellis et al. 1991)[5]. Most systems interpret the common group context as a space, a room. The definition of the metaphor room ranges from a room being a space to arrange documents over a social space for group interactions up to a virtual counterpart of the real world. The latter finds its expression in the so called CVEs (Collaborative Virtual Environments), such as the avatar worlds of DIVE or MASSIVE. [6]. One good example for the idea of mapping natural understandings of our world into behaviours and laws of the virtual world is the structuring of conversations in MASSIVE, where "nimbus" and "focus" of an Avatar defines the range an direction (audience) of its chat[7]. Thus people grouped in geographical proximity form a local chat group. This spatial understanding of a virtual room partly allows learners to interact with objects like they do in the real world—closeness defines semantic relationships between objects, avatars must be in reach of objects when interacting with them. Awareness in all forms–from simple information about people joining a chat session up to complex Avatars (which sometimes have graphical representations) of virtual worlds plays an important role in forming a feeling of being part of a social environment.

Another phenomenon takes place when people interact in rooms, which Bly, Harrison and Irwin [8] experienced in their MediaSpace System. People develop a common feeling of being at home—a space develops into a place—people behave in the social and cultural pattern of the real world. Out of the same reasons players of most MUDs and MOOs develop a feeling of being a virtual community – they develop laws, netiquette and social forms of interaction for their world!

For the further exploration of the concept of learning supportive shared media spaces we set up a few prototypes providing virtual rooms. (Technically speaking we connected document management functionality and a highly

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[4] For a short description of our concept of media functions see: Hampel, T. (2000). Scenarios of a New Dimension of Learning by the Cooperative Structuring of Knowledge, *Proceedings of the World Conference on Educational Multimedia, Hypermedia & Telecommunications*, Bourdeau, J., Heller, R. (Eds.), Montreal, Canada, June 26-July 1, 2000.

[5] *"Many task require an even finer granularity of sharing. What is needed is needed are shared environments, that unobtrusively offer up-to-date group context and explicit notification of each user's actions when appropriate."*

[6] For an overview on CVEs see e.g. Benford, S., Brown, C., Reynard, G., Greenhalgh C. (1996). Shared spaces: transportation, artificiality, and spatiality. *Proceedings of the ACM 1996 conference on Computer supported cooperative work*, November 16 - 20, 1996, Boston USA , 77-86.

[7] see Greenhalgh, C., Benford, S. (1995). MASSIVE: A Collaborative Virtual Environment for Teleconferencing, *ACM Transactions on Computer-Human Interaction*, Vol. 2, No. 3, September 1995, 239-261.

[8] for the notation of *media spaces* see e.g. Bly, S., Harrison, S., Irwin, S. (1993). Media Spaces: Bringing People Together in a Video, Audio and Computing Environment, *Communications of the ACM*, 36(1), January, 1993.

event-oriented communication server.) These rooms are both private working spaces for learners and public group work environments. Learners may easily create personal rooms and rooms are administrated by cooperating learners themselves. We call this idea the concept of self-administration. Our first experiences show, that through the metaphor of rooms learners develop a quite accepted and natural understanding for document- and learning spaces. Semantic relations to other rooms are expressed through doors and exits provide a real world understanding of the structure of the virtual. This does not mean that a door must be represented by an icon of a door or even has to be in three dimensional or virtual reality, just the expression "door to library" forms a correct understanding of the plan of entering a door, leaving the room and the need to have appropriate access rights to do so.

Roles and access rights

Another crucial characteristic for flexible forms of learning in session based environments are social roles. In nearly every of today's learning situations social roles are an central form of structuring the learning process. Let's imagine a typical tutorial situation, where a student presents some findings of a small group and therefore enters the role of a moderator. The moderator structures the flow of the communication, as he/she allows parts of the group to interfere or to suggest different topics to discuss. A moderator may also record or make notes of important contributions for the target discussion. Classical policy systems and access control lists normally comprise only a static definition of access rights and therefore support only static roles in group work. But it is a quite natural process of every face-to-face or virtual meeting situation that flexible changes of roles take place. So systems have to support an easy mechanism for the change of roles during an cooperative learning and working process. (See the concept of dynamic roles in (Edwards 1996)). Our prototypes accomplish this by a very flexible set of access rights which can be specified for every object (e.g. room or document) and can be inherited by parent objects or an master object within the room, or the room itself. Flexible temporal relations between learners and appertaining groups allow the adaptation to different learning situations and open forms of cooperation. A significant factor for people learning in such groups is that the participants in a discussions are aware of the persons joining the discussion and are also aware of the roles the different persons inhabit. For an computer mediated communication it seems essential to support such flexible forms of roles and access rights for documents and learning objects. Our approach of cooperative learning which aims to support face-to-face and all forms of tele-learning situations allows flexible roles through four key requirements: Firstly the easy attachment of person to roles, which is another form of self-administration as a room administrator gives other learners or colleagues temporally access to learning objects. Secondly, the flexible visualization of the roles a person inhabits at a certain time–which may be one form of awareness. And finally the free change of roles and therefore the flexible modification of access rights to documents and learning objects.

Annotations and structured chat

Another idea which smoothly fits into the concept of flexible roles is the flexible usage of annotations and a new form of chat that we call structured chat.

From the very beginning of hypertext and hypermedia systems[9] annotations played an important role in the research on cooperative group work. The simple concept of allowing learners to add personal notes to documents is a crucial pre-condition for the personal structuring of knowledge. Many closed hypertext systems supported various forms of annotations, including access rights on annotations and the differentiation between personal and annotations of the group. Surprisingly not one of the systems developed to be a common success and today's world wide web provides only browser bookmarks as marginal way to personally structure the web.

Our understanding annotations is two-dimensional: The ability to add personal or public information to internal and external resources and the ability to connect communication mechanisms and various media.

The first demand includes the challenging problem of allowing external annotations on every material found on the web. Closed hypertext systems usually provide for several forms of annotations, but the claim to do this also for every media on the web is hard to solve, because of the lack of WWW technology which is not prepared for any annotation mechanism.

Existing solutions use some sort of special annotation server which stores user annotations on web pages in a database modifying the pages on the fly while browsed by the user. (This is necessary out of several reasons, e.g. normal web users are not allowed to modify extraneous web servers.) Existing systems such as CritLink[10] are to be distinguished from our approach. Their software mediator implements the idea of web annotations for everyone but is not part of any cooperative work or learning environment. Out of this reason annotations are sepa-

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[9] A Conceptual Framework for the Augmentation of Man's Intellect, Douglas C. Engelbart, Vistas in Information Handling, Howerton and Weeks [Editors], Spartan Books, Washington, D. C., 1963, pp. 1-29, Republished in Computer Supported Cooperative Work: A Book of Readings, Irene Greif [Editor], Morgan Kaufmann Publishers, Inc., San Mateo, CA, 1988, pp. 35-65. Also republished in Organization and Groupware, T. Nishigaki [Ed.], NTT Publishing, 1992.

[10] see the CritSuite website at http://crit.org. Refer this site also for links to other approaches such as Xanadu, CoNote, ComMentor.

rated from any learning scenario in which learners integrate personal learning materials with external web resources. Our demand goes far beyond this approaches: Annotations should be attachable to every page on the web (only a few restrictions apply e.g. when the pages are dynamically created) and annotations are part of the learners´ cooperative learning environment. For a period of two years we worked on solutions to implement systems which allow a free combination of internal and external annotations. Our latest prototype allows the learners to annotate most documents of the web. These annotations are integrated in our sTeam system for cooperative learning and are handled as "normal" steam objects. Therefore access rights, all sorts of properties[11] and functionalities to rearrange objects within the learners context may be applied. Parallely, we developed a small prototype which explored concepts of connecting annotations and structured discussions—we call this concept structured chat.

Structured chat—bringing chat into context

The concept of structured chat aims at a the scenario of small groups of learners discussing and working with learning materials. This may take place in a virtual meeting, but also as part of an face-to-face situation during tutorials or lectures. Looking at such a scenario typically several discussion topics appear in parallel during a conversation. Sometimes smaller groups of learners work on a different topic than the rest of the group. Often, chat-statements refer to a much earlier contribution of another learner. In productive sessions, chat contributions refer directly to objects in the context of the group, e.g. documents or web pages. Our experiences show that out of this reasons a classical chat does not work properly. Another reason is, that in traditional chat communication every chat line must follow the earlier statement of another learner.

The concept of structured chat is a combination of classical synchronous chat and a tree widget. Here chat lines may be attached to every object within the learning environment. Every object in the learners context is represented by a branch in the structured chat. In a special area below the tree section learners may enter contributions to previously selected topics of the chat. Simultaneously, chat annotations may be attached to every object and appear in the tree at the section of the corresponding item. In this way each branch of the tree represents related objects and corresponding chat entries and annotations. It generates a persistent collection of related contributions which may be also used by learners who are not engaged in the entire discussion as a repository for questions and answers. If learning objects are grouped or linked (a simple relation may be defined by dragging one object very close beside another one) these objects are arranged on one level within the structured chat. Accordingly documents representing a common learning subject (e.g. documents and web pages describing a criteria of software design) are grouped in spatial proximity, which complements our human capacity for manipulating spatial memories.

Our initial goal regarding the concept of combining chat and annotations is two dimensional: On one hand chat conversation somehow develops the structural quality of an annotation and on the other hand annotations simultaneously inherit the flexibility of an chat. Important for the idea is, that the creation of objects in a room (comparable to an cooperative whiteboard) automatically generates a new subject within the structured chat. This entry may later be deleted, but learners are directly able to contribute to each others actions. (A concept which may also be described as a new form of workspace awareness.) Actions of learners create anchors for the annotation of relevant contributions of other learners. Analogous chat lines within the tree are visualized as annotations on the corresponding objects (may be viewed by the learners by pressing the right mouse button, or used as a tool tip by placing the cursor over the object for a while). In further developments different forms of chat persistency may be implemented. May be it would be a good strategy just to store annotations directly made on objects on the cooperative workspace and not to record every chat statement. It could be also necessary to provide a very informal not persistent chat as a second instrument for learners to communicate.

In addition, we experimented with different design solutions for the visualization of the learners´ awareness of each other and their actions. In cooperation with the project group for media design at the University of Münster, we developed a form of awareness visualization which is specially shaped for rather small groups of learners. Here, in a kind of circle, members of a chat are visualized as small coloured dots. The names (or nicknames) of the group members are shown right beside these dots. To illustrate the group activity the distance between the centre of the circle and a learners dot is proportional to their chat activity (e.g. chat statements per ten minutes). With the help of this simple approach we become aware of members actively working on a special subject and it seems easier to contact them or to integrate less involved learners into the conversation. One example for the importance of such information awareness might be that the silence of an online interlocutor may be interpreted as him/her not attending the monitor. A similar "Babble" approach by Erickson (see Erickson et. al. 1999) calls this

[11] sTeam supports an approach of user-definable attributes of learning objects, compare Dourish, P.W. Edwards, W.K., LaMarca, A. Lamping, J. Petersen, K. Salisbury, M., Terry D. B., Thornton J.: Extending Document Management Systems with User-Specific Active Properties, *ACM Transactions on Information Systems.* 18, 2 (Apr. 2000), 140-170.

graphical representation of users and their activities a “social proxy”. Their system integrates elements of bulletin board systems and chat. A topics list provides an overview about the ongoing conversation, and a social proxy creates a view on human activity on different channels. The research prototype from Rodenstein and Donath (see Rodenstein & Donath 2000) takes the same direction: A representation of coloured circles in a two-dimensional space provides awareness of users` actions over various audio-channels.

Rooms - Private and public boundaries – modes of cooperation – access rights and self-administration

Another crucial design issue when discussing the design of a computer supported cooperative learning space is the interrelations between personal and group/public workspace. Working with documents means to arrange them. This well known personal process of structuring the document world around us is one of the main forms of building personal cognitive structures and relations between things—just remember the typical “chaotic” forms of working which means arranging documents on everybody’s personal desktop at home or office. (Büscher et al. 2000) describes this process quite well: *“We found that manipulating the presence and absence of materials, bringing them into dynamic spatial relations, and referring between them, are not just context or perquisite for doing the work; rather, they are an integral part of accomplishing the work itself.”* When transporting this form of individual work into the scenario of group learning our findings of setting up learning supportive infrastructures show that both different modes of cooperation and different boundaries of a working space are necessary to be designed.

Haake and Wilson distinguished three main modes of cooperation: *individual mode, loosely coupled mode* and *tightly coupled mode*. These forms of cooperation were first explored and defined by (Haake & Wilson 1992) working on a collaborative writing tool and we adapted them for the scenario of cooperative learning. The notation of a loosely coupled mode may be described as a form of cooperative working and learning where learners access a common document space, but an appropriate locking of the learning objects takes place when a person makes modifications. This implies that the environment has to provide a form of activity or workspace awareness to recognize the actions of other learners. Tightly coupled modes of cooperation are characterized by their all synchronous, active forms of cooperative learning. Our approach prefers a mixture of individual mode and loosely coupled modes of interaction. In our first prototype individual working and learning is supported through personal workspaces which allow to structure and arrange documents individually. These personal workspaces may be expressed through the metaphor of a learner’s private room or in form of a personal workspace beside the group workspace/room.

The public or group workspace adopts the concept of the relaxed “What You See Is What I See (WYSIWIS)” (Stefik et al. 1983) version. Learners do not share a strict meaning an identical view on artefacts and actions of other learners, but a individually generated, relaxed perspective. Note that the separation between individual and group workspace does not intend restriction on interactions between these two spaces. Learners should be able to freely transport objects from their personal working space to group working spaces and vice versa. Therefore a tight coupling between these two spaces is initiated. Taking a more detailed look at the concept of rooms, the metaphor room concerning our approach serves many different functions. First, as mentioned before, it is a natural metaphor for the arrangement and storage of learning artefacts. A room is therefore a space to store, arrange and transport artefacts. Thus rooms define boundaries for the accessibility of the cooperative learning artefacts. Normally access rights for learning objects are derived from the accompanied access rights of the room. A simple metaphor could be a closed room door excluding people who do not belong to a particular group of learners.

Secondly also the spatial layout of a room works as a natural boundary for social interactions .

This quality of virtual rooms was shown the first time by various studies about the social interactions in MUDs and MOOs (Becker & Mark 1998). People develop a feeling of being at “their place” within the MUD and thus develop complex rules for social interactions (e.g. netiquette) in the virtual world. Consequently, our prototypes limit a chat to the participants which are virtually present in one room and is even more structured through its content (learning artefacts) regarding our concept of structured chat. As a result, rooms define areas which support different social groupings and simultaneously are boundaries for co-presence of other learners. Thirdly, in comparison to the real physical world, a room can unite both functionality and tools. In such a grouping functionality stands for different activities the room is place and stage for. A room may be described as a discussion or brainstorming room, holding special tools to record a conversation or graphical whiteboard systems to support a creative design process. Other rooms may contain tools for cooperative browsing and for the search of electronic libraries and may therefore be called a library. And last but not least a room could function as a lecture room sharing cooperative presentation- and protocol tools for the learners.

Indeed connections between rooms (called exits in our approach) allow to built semantic structures of rooms. Analogous they represent the social structure of the learning community and should be arranged in a layout reflecting courses and groups of learners.

In summary, one can say, rooms containing tools and persistent learning artefacts may be one of the key concepts for successful cooperative learning processes. Combining our interpretation of necessary access rights and social roles, we came to the logical conclusion of self-administration of these learning rooms. We developed a system of access rights which explicitly defines rights to give away/handle over rights to other learners within the system.
Starting at the point a new learner wants to join a learning group up to the specific adapting of a social role in a discussion process self-administration means that administration is a distributed and constantly applied process of changing access rights and group memberships.
The quality "distributed" serves our demand for social places and boundaries for documents that are administrated completely by the group itself. (This does not imply that there must not be a person in the group holding the predicate of the room administrator, which e.g. could be a tutor or lecturer. However, administration is a distributed process over several persons and groups of learners.)

Conclusions

Research on computer supported co-operation in learning processes is now conducted for more than twenty years. Unfortunately, only a few applications out of the field of computer supported cooperative work made their way into our offices. Today at the universities and schools only common standard web-technology is used to place learning materials (courseware) onto web servers—a one way road of co-operation which leads to isolation. Some people think this isolated learning situation could be eased just by providing bulletin board systems and e-mail to guide a learning process and establish successful connections between learners and teachers. This may be right to a certain degree, but lacks persistency, as long term learning processes as well as the every day viability of the learning materials is not guaranteed. In this article we have intended to elaborate why this deficit can only be solved by the combination of various key concepts, such as the metaphor of places and rooms, awareness components, the integration of synchronous and asynchronous forms of cooperation and communication, and new methods of structuring and through the annotation of learning materials. Therefore the selected infrastructures aim at both situations of cooperation and learning—the support of unanticipated group activities and all the forms of long-term participation.
The system which is currently under development does not claim to solve all existing deficits—it is rather an "open" approach regarding both the concepts and the implementation (source) allowing people to easily join our initiative. We, the developers, will hopefully benefit from the prolific and creative process of the co-operative improvement of concepts and applications.

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