What makes groups learning effectively in a videoconference setting?

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Abstract: In an experimental study designed to test co-operative learning in a videoconference setting, dyads were formed to work under three different conditions: "without a shared workspace", "with a shared workspace", or "with a shared workspace plus a content-specific graphical representation". The dyads without a shared workspace used more verbal co-ordination than both other groups. The dyads working with a shared workspace plus a content-specific graphical representation demonstrated better quality in their collaboratively written texts. The quality of this collaborative process resulted in better individual acquisition of important knowledge units. The study demonstrates that content-specific graphical representations make cooperative learning in videoconference-based learning settings more effective. The overall effects of a shared workspace were not so clear and should be further investigated.

Keywords: shared workspace; video conferencing, cooperative learning.

Introduction

Desktop videoconference settings are becoming increasingly interesting for cooperative learning in net-based communication environments. But so far there have been only a few investigations into how such learning settings should be arranged for potential enhancement of collaborative learning (Kopp, Ertl, & Mandl, 2004). In videoconference-based learning settings the groups are often not only supported by video, but they can also use shared applications or shared workspaces (Rummel & Spada, 2005). Until now, there have hardly been any empirical investigations concerning the effects of these shared workspaces. The present study aims at investigating whether a shared workspace in a videoconference-based learning setting makes the coordination of collaborative activities easier, whether there is a resulting positive effect on the learning process, and whether a content-specific graphical representation used as a scaffold is able to facilitate collaborative knowledge construction and learning in this setting.

Theoretical framework

Effects of a shared workspace used in video-based collaborative learning

A number of investigations into using videoconferences for collaborative learning provide evidence that there are no substantial disadvantages of videoconferences as compared to face-to-face cooperation. Neither process variables nor learning outcomes are affected adversely (Fischer, Bruhn, Gräsel, & Mandl, 2002; Jucks, Paechter, & Tatar, 2003). In view of the fact that videoconferences have certain natural limitations in comparison with face-to-face communication (Bruce, 1996; Finn, 1997) the results of these investigations suggest that learners in videoconference-based settings make more of an effort to compensate for these limitations in communication (Fischer & Mandl, 2002). However, in many videoconference-based settings the groups are not only supported by video, they can additionally work with shared applications or shared workspaces. There has been a lot of research on using shared workspaces in settings without video. These studies have investigated the function of a shared workspace as external memory, they analyzed the collaborative processes in a shared workspace, or the role of a shared workspace in the development of shared cognition (e.g. Hoppe, Gassner, Mühlenbrock, & Tewissen, 2000; Reinhard, Hesse, Hron, & Picard, 1997; Suthers, Weiner, Connelly, & Paolucci, 1995). Altogether these investigations show that shared workspaces can be regarded as predominantly positive for collaborative learning.

This research has already shown that shared workspaces reduce coordination requirements for work-groups in both editing and design tasks (e.g. Dorish & Bellotti, 1992; Gutwin & Greenberg, 2002). It also has revealed that a shared workspace eases the task-related coordination of the group – including the coordination of the treatment of the task, the distribution of subtasks and the coordination in the course of the work routine (Cannon-Bowers & Salas, 1998; Whittaker, Geelhoed, & Robinson, 1993). And this lower coordination load allows for more discussion of the contents and in consequence can lead to increasing collaborative learning. Relieving the group from task-related coordination lessens the cognitive load of the learners and therefore also improves learning (Van Bruggen, Kirschner, & Jochems, 2002).

But contrary to these findings, other research points out that those coordination activities in learning groups which shared workspaces aim to minimize do not only have negative effects on learning. Co-ordination activities can also have positive effects if they increase referral to the learning content and stimulate meta-cognitive processes and the self-control of the learners (Rogoff, 1991; Wertsch, 1991). So it could be that if the use of a shared workspace reduces co-ordinative activities, it at the same time reduces activity which is topic related and would thus foster learning. So in sum, for the use of a shared workspace there is no clear evidence if the positive or the negative effects prevail

Effects of a content-specific graphical representation in video-based collaborative learning

A second aim of the present study is to test if a content-specific graphical representation used as scaffold facilitates collaborative knowledge construction and learning in the workspace-supplemented videoconference-based setting. The content-specific graphical representation functions as a content schema (Kopp, Ertl, & Mandl, 2004; Suthers & Hundhausen, 2001) as it is intended to structure the content to be learned. It appears to be able to diminish the distractions of mutual referencing in videoconferences (Finn, 1997), and to focus the learners´ discourse on the important topics. In this way, in the applied videoconference setting, a content-specific graphical representation should serve to structure the collaborative construction of knowledge. .

Studies that analyze the effects of content schemes in videoconferences have seldom been undertaken. However, with non video-based learning settings a number of studies have been conducted. In their study Suthers and Hundhausen (2001) showed that graphical representations make central characteristics of the learning object salient, and thus influence the learning discourse by "representational guidance". In this sense graphical representations serve as contextual anchors which support the learning partners in focusing the discussion on the contents relevant to learning. The presence or absence of the central topics becomes apparent to the learners through these external representations. These findings are supported by a number of studies which show that graphical representations can play an important role in the negotiation and co-construction of meaning during communication. Roschelle (1992) showed that diagrams could be social tools for attaining common meaning in a discourse, because they support individual thinking and facilitate negotiating of meaning. Van Boxtel, Van der Linden, and Kanselaar (2000) performed a study on collaborative students who constructed argumentative diagrams and concept maps. In their study, the requested product forced students to pay attention to key principles in the domain. The diagrams proved to be supportive for maintaining a shared focus on the task and on the communication process. Fischer, Bruhn, Gräsel, and Mandl (2002) examined the effects of graphical representations given to collaborative problem solvers. They found positive effects on the process and results of collaborative knowledge construction.

Based on these finding the following study is undertaken to test the effect of a shared workspace in a video-based learning setting, and to test the effect of a shared workspace with a content-specific graphical representation.

Method

Participants

Thirty students between the age of 21 and 35 took part in the investigation. They were randomly assigned to the three test conditions "without shared workspace", "with shared workspace", and "with shared workspace plus content-specific graphical representation". For each of these conditions, five same-sex two-person groups were formed resulting in 8 female learning dyads and 7 male learning dyads.

Material

As *learning material* we used a multimedia learning program about solar astronomy. It presents the learning content primarily by means of audio commentaries accompanied by animations and videos. For analyzing the content, students had to learn, we first had to analyze, how many different "knowledge pieces" this material presented. By experts we analyzed a total of 126 different knowledge pieces (KPs), each KP corresponding roughly to a proposition that was stated in the program, e.g. „the sun is a star". Due to the expert ratings a total of 30 KPs were classified as "important KPs" and 96 as "less important KPs".

As a *content-specific graphical representation* we used a blank flow chart, which formally represented the sequence of the concepts to be considered in the learning task. The learners had to designate the names of the boxes and rhombs of the flow chart and had to abide by those designations during the task. Thus, the graphical representation served as a content-specific externalization of main concepts and showed the relations between the concepts.

The *writing task*, which first had to be done individually, then collaboratively, and finally individually again, was the following: The participants had to describe the development process of a star, from the birth to the death of a star. The *video connection* was established by ViGO Meeting Point. The application sharing was accomplished by Microsoft NetMeeting.

Experimental design and procedure

The experimental session with a learning dyad covered four phases:

1st . Phase (30 min.): Each participant had to learn with the multimedia program individually.

2nd . Phase (40 min.): Each participant had to do a writing task (describing the development process of a star, from the birth to the death of a star.).

3rd. Phase (50 min.): The participants worked in dyads in the video conference. The task was the same as in Phase 2 (writing about the development process of a star), but as opposed to the second phase they now wrote collaboratively. But they were able to draw on their individually written texts from phase 2.

4th . Phase (40 min.): Each participant had to do the same writing task a third time (writing a text describing the development process of a star. This test served as post-test because it measured a participant's individual knowledge after the co-operative task.

Independent variable

The experimental conditions only differed in the tools the groups had during the videoconference (Phase 3).

Under the condition "without shared workspace" a learner could see the video picture of his/her learning partner, but no shared workspace was provided. For the collaborative text production, an editing window was given into which only one learner could type the joint text (centralized control; Noël & Robert, 2004). It was visible only for this learner. In the beginning of Phase 3 a dyad had to decide which of the two learners would type in the text. Because of the missing visual representation of the text for the other person, the learners had to rely solely on verbal exchange in coordinating the joint text production. Each learner could see only his / her private editing window with the individual text solution once it had been written.

Under the condition "with shared workspace" a learner could see the video picture of his / her learning partner, and a shared workspace was provided. Both learners could write in a joint editing window, but only one learner at a time. The right to write had to be passed from one learner to the other. Passing over the editing work was totally dependent upon the disposition of the learners. Moreover, the shared workspace also included the private windows of the learners with their individual texts they had produced during phase 2. That means that these texts were visible for both. In order to make completely visible a learner's text for both partners, one had to scroll the window. An example of this screen is given in Figure 1.

Figure 1: Interface under the condition „with shared workspace".

Under the condition „with shared workspace plus content-specific graphical representation" the same workspace was given as under the condition "with shared workspace". Additionally each learner obtained a sheet of paper with a flow chart visualizing the developmental stages of a star, which the learners had learned from the multimedia learning program. However, the labels denoting the boxes and rhombs were missing. The learners were instructed to insert the labels before jointly writing the text about the development of a star.

Dependent variables

As dependent variable we used process variables describing the verbal discussion and outcome variables describing the quality of the written texts.

Verbal discussion process

For the analysis of the discussion protocols of phase 3, an operable set of categories was developed, with an emphasis on the information dialogues of Dynamic Interpretation Theory (Hron, Hesse, Cress, & Giovis, 2000). Accordingly, a distinction was made between task-focussed dialogue acts (content-related, coordinative), dialogue control acts, off-task talk, and others. In this paper we only focus on coordinative utterances which we further divided into different subcategories:

- Utterances related to text editing and referencing to individual texts in the private windows. These utterances were additionally classified as to whether they showed topic-relation or not.
- Utterances related to deciding on the right to type.
- Utterances related to scrolling the private windows (only under the second and third experimental condition).
- Utterances about completing the flow chart (only under the third experimental condition).

Quality of the written texts

All the co-constructed texts from the videoconference in Phase 3 and all the individual texts written in Phase 2 and Phase 4 were analyzed by how many important and how many less important knowledge pieces (KP) presented in the learning program which where considered.

Expectations

The expectations were as follows:

H1: The shared workspace lessens the number of the coordinative utterances.

H2: The shared workspace with the additional use of the content-specific graphical representation increases the quality of the collaboratively written texts.

H3: The shared workspace with the additional use of the content-specific graphical representation increases individual knowledge acquisition.

Results

To test H1, the coordinative utterances during the discussions were counted and compared across the experimental conditions. Table 1 shows that the differences between the mean total number of coordinative utterances for the three experimental conditions only approach significance. However, the table also shows that under the condition “without shared workspace” significantly more utterances occur concerning the coordination of text editing and referring to the individual texts in the private windows than under the other two experimental conditions – for both kinds of utterances: with and without topic-relation. “Deciding on the right to type” did not differ under the three conditions. Coordinative utterances referring to “scrolling of the private windows” took place only under the two conditions where a shared workspace was present and made no difference. “Completing the flow chart” was done only under the condition „with shared workspace plus content-specific graphical representation“. The latter two types of coordinative utterances add to the total number of coordinative utterances under the second and third condition and account for the finding that the difference among the three experimental conditions only approach significance. There are no further differences concerning other types of utterances (e.g. content-related utterances, dialogue control acts or off-task talk).

Table 1: Mean number of utterances of the described categories.

	Without shared workspace	With shared workspace	With shared work-space & graphical representation	FValue
Coordinative utterances (total)	136.80	101.00	96.40	2.92^{+}
related to text editing and individual text in private windows *with* topic relation	67.00a	30.00b	22.80c	14.64**
related to text editing and individual text in private windows *without* topic relation	57.40a	27.80b	24.40b	19.86**
deciding on right to type	12.40	24.80	26.40	1.71
scrolling private windows		18.40	11.20	
completing the flow chart			11.60	t(8)=0.91

** p < .01 Means with different letters significantly differ with Scheffé post hoc.
$^{+}$ p < .10

To test H2, the number of knowledge pieces which were part of the collaboratively written texts in Phase 3 were compared across the three experimental groups. We differentiated between important and less important knowledge pieces. The 2x3 ANOVA with the within factor "Importance" and the between factor "experimental group" revealed no main effects, but did show a significant interaction which is shown in Figure 2.

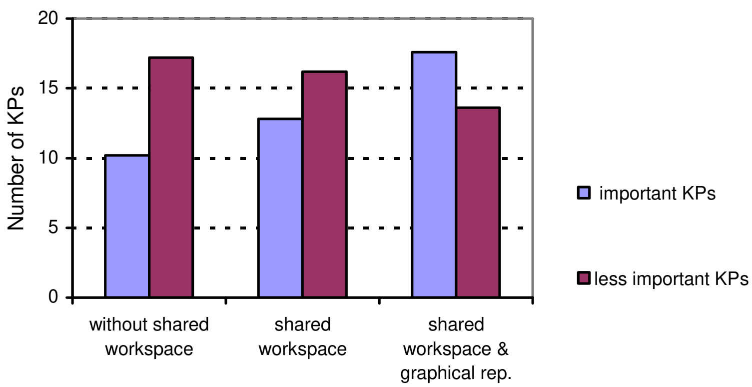

Figure 2: Mean number of important and less important knowledge pieces the texts which were collaboratively written by the dyads in phase 3 refer to.

The higher proportion of important knowledge pieces shows a higher quality of the collaboratively written texts. Thus, the shared workspace plus graphical representation did not lead to the consideration of more knowledge pieces, but it enhanced the selection of knowledge pieces which were considered for inclusion in the collaborative text. More important knowledge pieces were discussed and this supports H2 about a higher different quality of the discussion process in the different experimental groups.

To test H3, the number of the knowledge pieces the tests produced in the posttest (Phase 4) was counted and also a 2x3 ANOVA was done. The analysis revealed no main effects, but did reveal a significant interaction shown in Figure 3. This interaction for knowledge acquisition (on the individual level, Figure 3) is analogous to the interaction which was revealed for the collaboratively written tests (group level, Figure 2). Thus, a better individual knowledge acquisition is associated with the higher quality of the co-constructed texts (a higher proportion of important knowledge pieces). This does not mean that people actually knew more, but that they had acquired more of the primary concepts and relations than secondary ones.

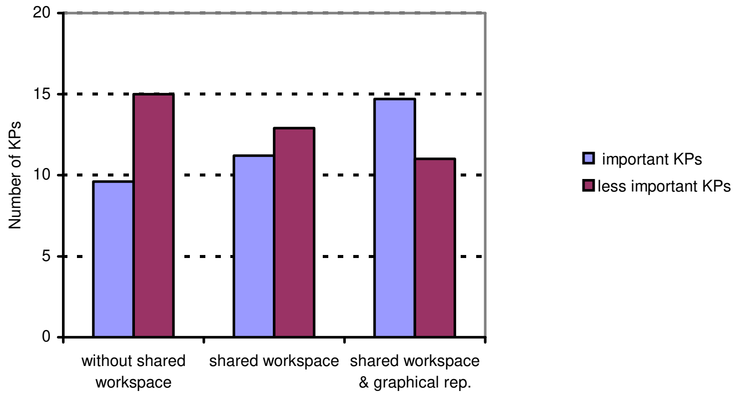

Figure 3: Mean number of important and less important knowledge pieces referred to in the texts which were individually written in Phase 4 (the post-tests).

Discussion

The present study investigated the effects of a shared workspace and the effects of an additional content-specific graphical scaffold in a videoconference-based learning setting. It considered the process as well as the outcome of collaborative learning.

The results regarding the effect of a shared workspace showed that the shared workspace could lessen the number of coordinative utterances in joint text editing. But compared to the condition with a shared workspace it did not lessen them to the expected extent. This is due to the fact that the use of the shared workspace itself (as well as the use of the flow chart) involves specific coordinative requirements. So the effort saved by fewer utterances for text editing was taken up not only by learning enhancing activities, but also by communication about scrolling or about how to co-ordinate the shared workspace.

However, according to the learning results those learners working without shared workspace did not show any poorer results in the quality of collaboratively written texts or individual knowledge acquisition than the learners under the condition "with shared workspace". This is due to the fact that the higher number of coordinative utterances caused by the missing shared workspace was associated with a substantial number of coordinative utterances referencing the learning content. This might have facilitated the cognitive processing of the learning content and compensated for the potential disadvantage of verbal coordination load due to the missing shared workspace. This result is consistent with the view that coordination activities in learning groups can have positive effects on learning if they increase referral to the learning content and stimulate metacognitive processes (Rogoff, 1991; Wertsch, 1991). This result clearly shows that the simple argument, "shared workspace lowers coordination load, which in turn leads to better learning outcomes", is not valid. To gain more insight into the associations and dissociations between team coordination and processing of learning content more research is needed definitely.

The results regarding the effect of a graphical representation used as scaffold in the "shared workspace" condition showed that this tool in fact had an impact on the outcome of the collaboration. It led to a higher number of important knowledge pieces in the collaboratively written texts, and to a higher number of important knowledge pieces in the individual knowledge acquisition. These results confirm the view that the graphical representation worked as a content scheme and supported the learners in focussing their discussion on the main ideas and in understanding the subject matter (Kopp, Ertl, & Mandl, 2004; Suthers & Hundhausen, 2001). Altogether, the results provide evidence that a content-specific graphical representation is a meaningful support in videoconference-based learning settings. In our study the learners achieved the best results it in the condition where learners had a shared workspace and a graphical representation. We assume that this effect would be even stronger if the graphical representation it itself part of the workspace.

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