Technology Selection for Small-Group Collaborative Distance Learning

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Abstract

This paper reports on a case study that was carried out to investigate small-group collaborative learning through real-time remote communication technologies. The aim of the study was to develop insight into relationships between technology characteristics and collaborative learning that may help in making technology selection decisions. In this study, audio-conferencing plus a shared workspace led to equal task performance as audio-conferencing without such an additional tool. However, adding a shared workspace to an audio-conferencing setting may lead to less equal participation, and participants' reportings indicated it may have a negative effect on the amount of effort learners put into the task performance. In contrast, audio-conferencing only seems to lead to *more* effort by *all* participants. Effort may be positively related to mental processing and learning, which leads to hypothetical technology selection guidelines.

Keywords — Media selection, small-group learning, audio-conferencing, shared workspace.

1. Introduction

Collaborative distance learning is an emerging area of particular relevance to professional learning/working settings. We view collaborative distance learning as located in the intersection area of computer-supported collaborative learning (CSCL) and computer-supported cooperative work (CSCW) [1]. We try to build on tools, findings and perspectives from both areas, thereby pulling CSCL and CSCW together [4].

The present study is an exploratory investigation into relationships between collaborative distance learning processes and technology that may support these, hoping to obtain insights that help make technology selection decisions. Our perspective of collaborative distance learning processes is an educational one. We work from a social-constructivist assumption of the usefulness of small-group learning settings [e.g., 7], and aim at long-term higher-level learning. To this we apply telecommunications applications for real-time communication that have been a focus in CSCW research on supporting collaborative design. In particular, we focus on adding a 'shared workspace' [2, 10] on learners' computer screens to audio-conferencing. (The resulting tools and methods are somewhat similar to audio-conferencing and audio-graphics as have been used for years in distance education settings, but their use --for true collaboration, not for instruction-- and thus their design is different.)

Two theoretical notions guide us. The first is from McGrath and Hollingshead [5, 6] who suggested a task/media fit hypothesis: the more complex the task in terms of interdependency of participants, the higher the information richness provided by the technology should be. The second notion is Salomon's [8] 'amount of invested mental effort'. Salomon suggested that a learner invests more mental effort in doing a task through a certain medium if s/he thinks this is difficult (but within a feasible range), and that this extra effort may lead to more learning.

2. Research Questions

In the context of two technological configurations that may support collaborative distance learning: audio-conferencing, and audio-conferencing with a shared workspace, we asked the following descriptive/comparative and interpretive questions:

- Which collaborative learning processes occur using the different technologies, with what effectiveness; are there differences?
- How may potential differences be related to characteristics of the technologies that were used?

3. Method

A multiple-case study was carried out within a simulated setting. Three mixed-sex groups of three advanced masters students of our faculty, all used to small-group learning, were formed. These participants were offered a follow-up on a philosophy course they had followed, in the form of five case-work sessions. The learning objective was: being able to solve ethical problems that contain a moral dilemma in a rational manner. The participants were instructed that after a session each of them should be able to argue rationally why the decision was made as it was made. The task is a complex problem-solving and decision-making task. It is also a non-visual task: it can be performed by using words; sharing of graphics (in a shared workspace) is not a baseline requirement for communication.

In the first session the groups worked face-to-face; we included this configuration for baseline comparison. In the second session the participants communicated through audio-conferencing. In the third session they were provided with the same audio link plus a shared workspace on their computers' screens. The group editing program Aspects [3] was used, which provided simultaneous access by all to the same document in a shared drawing space. A few weeks later in the fourth and fifth session they worked through audio plus a shared workspace and audio-only, respectively. These sessions were added to enable detection of novelty effects. Each session started with a practice task; then the 'real' task was carried out. The session was concluded with a semi-structured group interview. All sessions were video-taped.

Collaborative-learning processes were analyzed using Stymne's [9] observational system. This system is based on the idea that collaborative learning is a process of solving many small problems of different types. Task performance was measured by applying five criteria for rational problem-solving and decision-making regarding moral dilemmas to the group work process as captured on video tape. The interpretive research question stated above was approached through the group interviews. The remainder of this paper describes results from analyzing the data from one of the three groups that were involved in the investigation.

4. Results

4.1. Collaborative learning

Collaborative learing in terms of Stymne's categories could be described as follows. The groups payed attention to 60 to 86 small problems per session. The majority of these were 'production' problems, that is direct task-cognitive problems (78 to 91% of total time; 40 to 67% of the total number of problem-solving sequences). So most of the time was spent on solving the ethical problem. 'Planning' problems took approximately 5% of the available time, or 12 to 23% of all problems. Other types of problem-solving sequences were rare or their appearance could be assigned to novelty effects. Non-task behaviour was very rare.

Task performance evaluations showed satisfactory results in each of the sessions (7.5 to 10 points on a maximum of 10 points). Performance appeared to decrease a little over time. This could be explained by the work approach of the group, which first took a 'step-by-step' approach to the problem, but later on loosened this approach and tried to find 'shortcuts'.

The coding according to Stymne's system and the task performance measurements did not yield differences in collaborative learning processes between the different configurations of technologies. The participants' perceptions and experiences as expressed during the group interviews allowed an insider's view, however, which complemented and refined this conclusion, and led to a more in-depth understanding of aspects relevant to the technology selection issue.

4.2. Technology

According to the participants' own perceptions quite different effects of working through the two technologies (audio-only and audio + shared workspace) led to the same level of task performance in the end. The keyword appears to be 'effort'.

In the audio-only sessions more effort seemed to be required of the participants to achieve the same results as in the face-to-face and audio + shared workspace sessions. This effort related to more explicit structuring of the task content, of the already agreed-on issues, and of the planning and progress that was needed to maintain a shared understanding and a shared focus. In the audio + shared workspace sessions this information was easily available to all and could even be pointed at, as it was written on each participant's computer screen. In the audio-only sessions participants had to take their own notes, and together maintain shared understandings and keep a shared focus only by talking to each other. The individual note-taking as well as the explicit structuring took time, but also required much attention and active involvement by all participants. This was unlike working through audio + shared workspace, where in general only one participant at a time was busy typing the group notes, and the other two could lean backwards and 'see it all happen before their eyes'. Instead, audio-only required a shared effort. This also facilitated a positive group feeling, which, together with the perception that each of the participants had been actively and equally been contributing to the task performance, led to a positive evaluation of the group's performance by each participant.

In the audio + shared workspace sessions writing group notes in the shared workspace facilitated mutual understandings of task content, agreed-on issues, and planning and progress; explicit structuring through speak was much less necessary. Keeping a shared focus was also facilitated by the working in the shared

workspace. The visible group notes in the shared workspace gave the participants a more serious feeling of working on a shared product than in the audio-only sessions. This facilitated a positive group feeling. This group feeling was also influenced positively by the effect of telepresence that was created by seeing each other type, draw, or gesture (with the mouse pointer) in the shared workspace. Note-taking by only one participant at a time was sufficient; this utilization of effort and time was perceived efficient. However, it did not require all participants to be as actively involved as they were in the audio-only sessions. As a result, the participant who had written most of the group notes felt satisfied over the group's performance, as a result of her active involvement, the efficient task performance, and the feeling of having been part of a close group. The other two participants were satisfied over the group's performance because they had only put in as much effort as was necessarily required and had been working efficiently overall, and as they had felt a close group while working on a shared product. However, they were less satisfied over their own involvement in what they agreed was meant to be a learning task for all.

In sum, audio-only facilitated effective task performance through equal, active involvement and more effort by all. Audio + shared workspace enabled effectiveness without too much effort, by efficiency through inequal involvement.

5. Discussion

We conclude that collaborative distance learning can be as effective and satisfactory as face-to-face group learning. Deciding between audio-conferencing with or without a shared workspace, for non-visual tasks, seems a delicate issue however.

5.1. Task/media fit

McGrath and Hollingshead's [5, 6] task/media fit hypothesis is based on information richness in terms of social clues: the more complex the task in terms of interdependency of participants, the richer the information transmitted by the technology should be. Less complex tasks are for example brainstorming, which can be done collaboratively through text. More complex tasks involve coordination or conflict resolution, and require communication of (more) socially rich information such as evaluative and emotional messages in order to sufficiently reduce equivocality. Providing a group with a too 'lean' technology that would not be able to transmit sufficiently rich information to carry out the task would lead to effectiveness losses. A too rich medium, however, would distract the group by transmitting meaning that is non-essential for effective task performance, and thus lead to efficiency losses.

In our study both technologies used appeared to allow an effective fit. However, we did not find that adding a shared workspace led to efficiency losses. Most of the extra information richness the shared workspace offered, such as gesturing with the mouse pointer and visibility of the dynamics of others' editing on the screen, was found useful for coordination and keeping a shared focus. In the audio-only sessions, however, the participants were able to compensate for the lack of this richness. It seems that McGrath and Hollingshead's task/media fit hypothesis allows some 'freedom of movement' with respect to what is effective and efficient. Human adaptation capabilities and actual effort to compensate allow different patterns of factors to work equally effective and efficient.

5.2. Effort

Effort thus appears to be a key factor: audio-only requires more effort than audio plus a shared workspace to achieve the same level of task performance. Salomon [8] found that high perceived task/media demands led to high mental effort if they were within the range of perceived self-efficacy with regard to these demands. Audio-only was indeed perceived to be more difficult than audio + shared workspace; as the participants felt and appeared to be able to meet the requirements, they invested an appropriate extra amount of effort in their task performance.

Effort is often related to learning in that more effort would lead to deeper mental processing and thus to more learning [8]. From that we could recommend that for learning purposes audio-conferencing only should be preferred over audio plus a shared workspace (while the latter could be a better choice when task-related efficiency is merely aimed at). This recommendation should be restricted to learners with appropriate mental skills to compensate for the lack of information richness a shared workspace would offer.

6. Conclusion

From this study we conclude that collaborative learning over a distance can be as effective and satisfactory as face-to-face. For people with adequate listening and structuring skills in learning situations, audio-conferencing would be preferred over audio-conferencing with a shared workspace, because it requires and stimulates more mental processing.

The insights gained in this study allow us to speculate about a refinement of McGrath and Hollingshead's [5, 6] task/media fit hypothesis, using Salomon's [8] 'amount of invested mental effort' concept: mental effort allows some degree of freedom in task/media fit. This leads us to the following hypotheses with regard to providing media richness for learning:

- If you have to apply extra mental processing to handle 'noise', then less media is better.

- If you can compensate with your brain, then, with regard to mental processing, less media is better.
- If you cannot compensate with your brain, then more media is better.

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