Blended Learning as a Strategy to Improve Collaborative Task Performance

KARIN SCHWEIZER1, MANUELA PAECHTER2 & BERND WEIDENMANN2

1Heidelberg University of Education, Germany, 2Karl-Franzens-University, Graz, Austria and 3University of the Federal Armed Forces, Munich, Germany

ABSTRACT An empirical study was used to analyse how groups of learners work together in e-learning and blended learning environments. We compared three pure e-learning courses with one course whose e-learning phases alternated with face-to-face phases (blended learning). The participants of these courses formed learning teams consisting of four members who met at three points in time. They were instructed in certain topics in Psychology via five virtual rooms (pages) on the Internet (virtual classroom, electronic bulletin board, etc.). All learners received two types of learning material: joint material, to build shared knowledge, and additional information that was different for each group member (unshared knowledge). After a period of 2 weeks of individual e-learning the learning teams met as an asynchronous newsgroup, as a synchronous chat group, as a synchronous videoconference group, or as a face-to-face group (blended learning condition). In these learning teams students were requested to solve four different types of tasks together. The tasks differed with regard to whether they were already known from the individual learning phase and with regard to whether they referred to shared or unshared knowledge.

Among other variables we analysed were the students’ extent of online activity (e.g. number of logins), the groups’ task performance, and the coherence of the group discourse. The performance in the e-learning conditions was compared with the performance in the blended learning condition.

The empirical results show that achievement in a group of learners does not depend solely on the communication setting. An interaction between the communication setting and the type of task could be observed. If the group members had to share and exchange their knowledge to come to a joint solution they achieved better results in synchronous settings, especially in the videoconference and the face-to-face setting. These findings are supported by the results of a content analysis of the communication undertaken. Learners in the blended learning condition who worked together face-to-face led a much more coherent discourse than learners in the pure e-learning conditions.
Advantages of collaboration

Computer networks enable learners to be brought together who would otherwise not be able to communicate with each other. Thus, the participants of e-learning courses can also gain the advantages of collaboration that are described in approaches such as ‘Learning Communities’ (Almog & Hertz-Lazarowitz, 1999, p. 285) or ‘Communities of Practice’ (Wenger, 1998, p. 5). These approaches emphasise the beneficial effects of learning and working together (for an overview, see Jucks et al., 2003). They ascribe manifold advantages to group work:

- **Qualitatively or quantitatively better joint task outcomes**: A group may achieve better results than a single person. Or, a group of a specific number of people who work together and who coordinate their actions may achieve better results than the same number of people who work independently of each other. There are different explanations for such a beneficial effect. A group may have a wider range of knowledge and skills at its disposal. Also, working together may motivate the group members and lead to higher commitment.

- **Better individual knowledge**: Through collaboration group members may acquire a wider knowledge that incorporates multiple perspectives. There are different explanations for this effect. Vygotsky (1978, 1986) assumes that less knowledgeable group members learn from more knowledgeable ones. He defines a ‘zone of proximal development’, i.e. the distance between the actual individual development level and the level of potential development, which can be reached through problem-solving under the guidance of an experienced person or a more capable peer. Wittrock (1978), on the contrary, places more emphasis on the individual group member’s activities. If information is to be retained in memory, related to older information, and if a new memory structure is to be developed the learner must engage in some sort of cognitive structuring, restructuring or elaboration of the learning material. Communication about the learning material (e.g. explaining it to others) supports such (re-)structuring and elaboration.

- **Development of social skills** (for example, Webb, 1992): If team success relies on successful learning and on the commitment of the individual members, then team members’ activities should focus on helping each other, explaining concepts to each other, and encouraging each other to achieve. In the process of working together, supportive social behaviour can be learned (Slavin, 1992).

- **Gains in motivation**: For example, Cohen (1986) assumes that when faced with challenging and interesting tasks, students will experience the process of group work itself as highly rewarding. Group work may increase an individual member’s motivation and raise his/her efforts to achieve.

These considerations indicate various advantages for groups of learners who work together and share their knowledge. Cooperation, however, does not work by itself. Simply placing individuals into groups and telling them to work together does not create the effective conditions that result in the aforementioned outcomes. Whether the advantages of collaboration can be realised or not depends strongly on the peer learners’ discourse (Resnick, 1991; Scardamalia & Bereiter, 1994). What learners
say to each other influences the knowledge structures that they construct. Peer discourse provides speakers with an opportunity to integrate their ideas while speaking. Listeners may receive information that helps them to construct new ideas (Chinn et al., 2000).

There are several factors that contribute to a successful discourse in a group of learners. On the one hand, it has to be ensured that the group members understand each other’s concepts and contributions. During the discourse, the group members have to maintain and to ensure a mutual understanding. In the words of Clark and Brennan (1996, p. 127) they have to ensure a “common ground”. The communication partners try to establish what has been said and what has been understood. Therefore, the group members use means such as positive or negative evidences, visual and verbal back-channelling cues, or references to other contributions. An important means to reach a common ground is to refer to a former contribution of another group member. If discourse contributions are connected to each other by references, one speaks of local coherence (Tomlin et al., 1997; van Dijk, 1997).

Other important factors that support successful group work are the structure of the group discourse and the type and contents of their contributions. It is important that the members share their knowledge and give each other the information that is needed for solving the task. Therefore, different instructional methods have been developed that shape the learners’ discourse. These methods structure the discourse with regard to the roles of the communication partners or with regard to the type and the sequence of contributions. For example, the method of peer tutoring structures the group members’ discourse with regard to the type of contributions (explaining, asking, etc.) (Danserau, 1988; King, 1994; Palincsar & Brown, 1984). The jigsaw puzzle method uses a different technique. Here, different chunks of learning material are allocated to the individual group members. Hence, each group member becomes an expert in a certain area: each member of the group has different knowledge. The group then works on a task that needs the knowledge of all members and that can only be solved if all group members explain to each other what they know about the task (Aronson et al., 1978).

Collaboration in e-learning scenarios

In comparison with face-to-face learning, learning collaboratively in an online setting brings various changes. Of course, online learning generally enables discourse between remote learners and brings learners together who otherwise would not have had any possibility to interact and to learn with each other.

Yet, online learning and online discourse may differ from face-to-face learning and face-to-face discourse with regard to basic communication processes. In computer-mediated communication settings it can be more difficult to ensure a common ground of mutual understanding because established communication routines of face-to-face communication are not available. Collaborative task performance, however, depends on the degree to which learners are able to build a common understanding. This common knowledge base can be achieved through a coherent conversation. In certain communication settings, however, social behaviours and
interaction rules of face-to-face communication cannot be employed. In such circumstances, there is no smooth sequencing of turn-taking and therefore no thematic coherence (Murray, 1989). These discourse problems may pose a serious barrier to successful learning. In chat environments, especially, it is often difficult to maintain a logical sequence of the speakers’ contributions. Therefore, the group members have to develop strategies of linking contributions to each other; for example, by referring explicitly to a speaker’s name or to a specific contribution.

Online learning environments may also change the social relations and expectations that learners, co-learners, and tutors impose on each other (Schweizer et al., 2000). In online learning, participants meet in an environment in which they are rather anonymous and in which the social status of the individuals is less distinctly discernible. The communication partners can neither see nor hear each other. In comparison with such a setting face-to-face communication relies on numerous non-verbal and paralinguistic signs. For example, the communication partners maintain a certain body space and they employ facial expressions, gestures, and prosodic information to render additional information about the speech act (Austin, 1962; Searle, 1969; see also Clark & Brennan, 1996). Every face-to-face communication reveals something about the speaker’s current condition and his/her emotional and cognitive state.

Numerous studies have investigated the differences between face-to-face and computer-mediated communication (for example, Daft & Lengel, 1986; Short et al., 1976; Sproull & Kiesler, 1986; Walther, 1996, 1997). Especially when communication is mostly reduced to text-based asynchronous communication, the costs of ensuring a mutual understanding play an important role. The lack of non-verbal and para-verbal information often leads to inadequate verbal behaviours or even to depersonalisation and de-individuation problems as well as to difficulties in turn-taking and to a disorganisation (Kiesler et al., 1984). Yet, e-learning scenarios have often ignored the learner’s need for a socially rich communication in phases when learning contents are discussed. Often, one of the consequences is a large dropout rate.

Merging the benefits of classroom learning and e-learning

The problems already described and the resistance of many students, (especially distance education students), to collaborate require new strategies to be considered. According to Rosenberg (2001) face-to-face classroom learning can be used to support e-learning in certain aspects. In addition to the aspects already mentioned, he describes e-learning as short, targeted, task-driven, and episodic while classroom learning tends to be longer, less well-targeted, and programmatic. The benefits of classroom learning, however, are closely related to the increasing importance of the learners’ communication. When tasks require that learners build a common knowledge base about unshared learning contents, one should find a clear benefit of face-to-face communication. In such cases, learning should be supported through face-to-face discussions between the learners, and these discussions should not be
An empirical investigation of e-learning and blended learning

An e-learning course was offered to students in all faculties of the University of the Federal Armed Forces in Munich (computer sciences, business administration, education, etc.). It was an interdisciplinary seminar in which students received an introduction to the Psychology of Learning. The course was divided into three phases, each of which lasted 3 weeks. In each phase, computer-based learning material was distributed. After the distribution of the material, students had 2 weeks in which to acquire knowledge individually. In the third week of each phase, the students met in groups of four and tried to answer questions about the contents of the learning materials.

An Internet environment was implemented for the course that had been already evaluated in a former research project (Weidenmann et al., 2000). In that environment different learning and communication services could be accessed from a central webpage (Figure 1 illustrates the website).

A virtual classroom in which the learning material was presented in the form of computer-based training. Students could either download the material or receive it offline. In each learning phase, learning material was distributed that was identical for each student. In addition, learning material was distributed that was different for each member of a learning group.

A consultation room where the tutor gave personal feedback and answered questions about the learning material. Here, the students received learning material that was different for each group member.

A notice board where news and general issues about the course could be found.

An examination room where the students individually completed online tests on the learning material.

Furthermore, different communication services were offered for the group meetings. For those students who meet in newsgroups or chats the communication services could be accessed via the central webpage.

In the group meetings the students used one of the following computer-mediated communication (CMC) technologies: newsgroups, chats, or videoconferences. Other groups met face-to-face. Each group used the same technology at all meetings. Hence, there were groups who worked in a pure e-learning course (newsgroups, chats, or videoconference groups). In addition, there were groups who worked in a blended learning condition, namely those who met face-to-face.

Independent variables

We varied the following independent variables.

First, the type of learning:

1. e-learning with additional asynchronous newsgroup communication;
2. e-learning with synchronous chat group communication;
3. e-learning with synchronous videoconference group communication; and
4. blended learning with synchronous face-to-face group communication.

The learners in newsgroups communicated asynchronously. Therefore, they had a period of 1 week in which to complete their tasks. All other groups communicated synchronously. These groups met at one point in time and finished their work in that one meeting. The groups, however, could work together for as long as they wished.

Second, the type of task; that is, questions about the learning material (compare later description).

At each meeting, the groups received four different types of tasks:

1. An already known task based on unshared knowledge, i.e. a question about the additional learning material that was different for each group member. This question was already known from the individual learning phase. As each group member had received different learning material each member received a different question which only he/she could answer.

2. An already known task based on shared knowledge. This task referred to the joint
learning material (shared knowledge) and was already known from the individual learning phase.

3. A new task that referred to the joint learning material and that was not known from the individual learning phase.

4. A so-called jigsaw puzzle task that was based on unshared knowledge. This task could only be solved if the group members explained their individual knowledge to each other.

These tasks varied in their demands on the exchange of knowledge: a single group member could solve task type 1 since it refers to learning material that was only distributed to that group member. It was only necessary that all members of a group answer their questions. The need for an exchange of knowledge increases from task type 1 to 4. Task type 4 can only be solved if all members exchange their knowledge. Another independent variable was the time with three points in time (group meetings).

**Dependent variables**

Among other variables we recorded the logins (without group activities and the access of the learning material in the virtual classroom), the percentage of correct answers for each type of task, and the coherence of the conversation.

For the evaluation of group performance the groups’ answers in their joint meeting were evaluated by a content analysis. We noted how many arguments from the learning material were stated. The percentage of arguments stated was then compared with all relevant arguments in the learning material. For task type 1 the mean percentage of the four answers was computed.

In order to analyse the coherence, all the group meetings were recorded and the students’ discourse contributions were stored on the server of the e-learning environment or on videotapes. The number of contributions that refer explicitly to each other measured coherence. The group members could make different kinds of references. For example, they could refer to a former contribution by giving the name of the speaker or in the chat and newsgroup setting by giving the time at which a former contribution was sent, they could repeat a contribution or a section of it, and so on. For each group member the number of explicit references to one of the last five contributions was computed.

**Research questions**

The following research questions were investigated:

1. What level of group performance do e-learning and blended learning groups achieve?
2. Is there an interaction between the learning scenarios and the type of task with regard to group performance?
3. Are there differences between the three points in time, i.e. the three group meetings?
4. Are there differences in the coherence of the groups’ discourse in e-learning and blended learning settings?

Sample

Ninety-six students of the University of the Federal Armed Forces took part: all were male and all were in their first study year. They were assigned to 24 groups of four; that is, six groups in each CMC setting. With only two exceptions, the students took part until the end of the study. The participants, all aged between 20 and 26 years, were studying different subjects (computer sciences, engineering, business administration, etc.). They were participants of four (identical) interdisciplinary university courses that lasted two terms. In the first term, the students received a thorough introduction into the use of the Internet and of all communication technologies employed in the study. In the second term, the course took place on the Internet and in the virtual groups as described beforehand.

Results

Altogether, students logged in 4246 times. This is a mean number of 44.23 logins per student. This number, however, does not include the logins for group activities or the logins for working with the learning material (these logins could not be recorded by the Internet software). The mean number of 44.23 logins is for access to the notice board, to the tutor’s office, and to the test room: this indicates that the students actively took part in the learning process.

Research questions 1 and 2: group performance in different tasks and different learning scenarios

Referring to the dependent variable ‘group performance’, a multivariate analysis of variance with the factors ‘learning condition’ and ‘point in time’ was computed for each type of task. The analysis showed significant differences for three types of tasks:

- Task type 1, the already known task based on unshared knowledge ($F (3/92) = 15.931, p < 0.001$): as Figure 2 shows, newsgroups achieve less than all other groups.
- Task type 3, the new task based on shared knowledge ($F (3/92) = 14.455, p < 0.001$): again, newsgroups achieve worse results than all other groups. At point in time 2, face-to-face groups achieve better results than videoconference and chat groups.
- Task type 4, the jigsaw puzzle task based on unshared knowledge ($F (3/92) = 25.698, p < 0.001$): at point in time 1, videoconference groups achieve the best results. At later points in time, face-to-face groups achieve higher outcomes than the newsgroups and chat groups and similar outcomes as the videoconference groups. Furthermore, it is noteworthy that the achievement in the newsgroups is extremely low.
In summary, Figure 2 shows that the face-to-face groups do not always do best in terms of performance (see also Schweizer et al., forthcoming).

**Research question 3: differences between the three points in time** The second factor of the multivariate analysis ‘point in time’ also shows a significant effect, this time for all types of tasks (task type 1, $F(1/72) = 17.94, p < 0.001$; task type 2, $F(1/72) = 55.11, p < 0.001$; task type 3, $F(1/72) = 52.29, p < 0.001$; task type 4, $F(1/72) = 4.97, p < 0.05$). A monotonic increase cannot be found. However, it cannot be guaranteed that the difficulty of the three tests is identical, even though this was tested in a pilot study. Furthermore, the last learning period coincided with the end of term, at which time students had more assignments to complete and probably had less time to work with the learning software.

**Research question 4: differences in the coherence of the groups’ discourse in e-learning and blended learning settings** Another dependent variable was the coherence of the conversation (Figure 3). Again, a multivariate analysis of variance with the factor ‘learning condition’ and ‘point in time’ was carried out. Once again, there is a highly significant factor ‘learning condition’. This indicates that learners in the blended learning condition seem to be more co-oriented than in the pure e-learning condi-
FIGURE 3. Coherence of the discourse in three conditions of e-learning and blended learning.

...tions ($F(9/107.235) = 14.965, p < 0.001$). Only in the third phase (point in time 3) do the face-to-face groups make fewer explicit references than do the videoconference groups. The factor ‘point in time’ is also significant ($F(6/41) = 5.12, p < 0.001$).

**Discussion**

Distinct differences between the pure e-learning settings and the setting in which e-learning alternated with phases of face-to-face discussions were found. The performance in certain tasks varied with the communication setting. When student groups were faced with a task that required them to exchange knowledge, to evaluate it, and to come to a common result, they performed better in face-to-face or videoconference discussions. Yet, the face-to-face groups did not always come off best in terms of performance.

How can one explain these results? First, one should have a look at the task. The groups were faced with tasks that varied with respect to the necessity for knowledge exchange. Knowledge exchange and a coherent discussion were least important for the already known task referring to unshared learning material (task type 1) and for the already known task referring to shared learning material (task type 2). The jigsaw puzzle task (task type 4) posed the highest demands on the exchange of knowledge and on the coherence of the discourse.

Second, one has to look at the characteristics of the communication in different settings. Newsgroup communication can be characterised by the lack of auditory and pictorial context cues, by written communication, by asynchronicity and hence time-delayed feedback, and by the possibility to store messages on the computer.
Newsgroups had a period of one week in which to answer the questions about the learning contents. This meant that the group members had to access the online communication environment several times in order to read the contributions of the other group members and to compose their own messages.

In the chat communication, context cues were also missing; one also has to write respectively to type messages. It was also possible to store messages, but feedback could be given immediately. However, it is difficult to maintain coherence in chat discourse. Group members might have composed messages at the same time and sent them simultaneously. Hence, the thread in the conversation gets lost easily.

Videoconference and face-to-face communication transmit auditory and pictorial context cues and allow immediate feedback to be achieved. However, it is not possible to store the discourse contributions. On the contrary, group members can talk to each other. Videoconferences also enable a ‘rich’ communication (as defined by Daft et al., 1987) because they allow immediate feedback, a multiplicity of cues, greater personalisation, and a greater language variety. However, compared with face-to-face communication, videoconference communication still poses restrictions: it is neither possible to establish eye contact between two people, nor to address a person explicitly. This restriction may impair turn-taking and, hence, the coordination of spoken contributions. In videoconferences the communication cannot be individualised. Therefore, only one conversation can effectively use the medium at any point in time. Parallel conversations are extremely difficult to be monitored and to be coordinated.

The four communication settings investigated differ with regard to the effort and the costs that are needed for a coherent exchange of information. In newsgroups the group members have to invest a lot of effort if they take part in the discourse. Group members have to access the environment several times. Furthermore, communication in newsgroups is accompanied by uncertainty about the group members. It is difficult to predict how many contributions the other members will make and when they will store messages and task solutions in the Internet environment. Furthermore, the contributions seldom refer to each other (see Figure 3). These difficulties explain why the groups showed a lower task performance in task types 3 and 4, the jigsaw puzzle task. Why, however, did newsgroups come off worse in task type 1, the already known task on unshared material? Here, students did not have to exchange their knowledge as each student could answer the question on his own. Further analyses indicate that in newsgroups the students participated only sporadically in the collaboration (Paechter, 2003). This low participation might be due to the combination of uncertainty and the high effort that is needed for cooperation.

Chat groups partly achieved similar results as the videoconference and the blended learning groups. However, they showed worse results in the jigsaw puzzle task. This result can also be explained by the basic conditions of the discourse. In chats, it is especially difficult to maintain coherence. Hence, the thread of the conversation gets lost easily. The empirical results shown in Figure 3 confirm this assumption.

There are few differences between the face-to-face groups and the videoconference groups. In both settings, the group members meet at the same time and can
talk to each other. Yet, it seems to be more difficult to maintain a coherent discourse in videoconferences.

In summary, the empirical results show that the achievement in a group of learners does not depend solely on the communication setting. An interaction between the communication setting and the type of task could be observed. If the group members had to exchange their knowledge to come to a joint solution, they achieved better results in synchronous settings, especially in videoconferences and face-to-face. Newsgroups were suitable for group work only if the exchange of knowledge was not important for task performance. However, it seems that in newsgroups the group members need more encouragement to contribute to the cooperation. The results also show that it is not always necessary for the members of a learning group to meet face-to-face.

These results give useful indications for the implementation of e-learning and blended learning courses. They show that the efficiency of the cooperation between peer learners depends on the communication setting as well as on the type of task. If one has to decide on a certain instructional method for peer cooperation, one should keep the following things in mind: first, what demands does an instructional method impose on the learners’ discourse? and, second, can these demands be met in a specific communication setting?

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Notes on Contributors

MANUELA PAECHTER is a professor of Educational Psychology at the Karl-Franzens-University of Graz (Austria).

KARIN SCHWEIZER is a deputy professor of Educational Psychology at Heidelberg University of Education, Heidelberg (Germany).

BERND WEIDENMANN is a professor of Educational Psychology at the University of the Federal Armed Forces, Munich (Germany).

Correspondence: Prof. Dr Manuela Paechter, Karl-Franzens-University Graz, Institute of Psychology, Universitätsplatz 2, 8010 Graz, Austria; E-mail: manuela.paechter@uni-graz.at

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