A closer look on social presence as a causing factor in computer-mediated collaboration

Miriam Weinel [a], Maria Bannert [b,*], Jörg Zumbach [c], H. Ulrich Hoppe [d], Nils Malzahn [d]

[a] Pedagogy of E-Learning and New Media, Chemnitz University of Technology, Germany
[b] Chemnitz University of Technology, Straße der Nationen 62, 09107 Chemnitz, Germany
[c] Department of Science Education and Teacher Training, University of Salzburg, Austria
[d] Department of Mathematics/Computer Science, University of Duisburg, Germany

ARTICLE INFO

ABSTRACT

So far, research in computer-mediated collaboration has investigated various factors influencing the amount of social presence experienced in online settings. This experimental study broadens the perspective and investigates social presence as a causing factor on participants' perception on task, medium and collaboration. Therefore an experiment with between subject design was conducted, with manipulation of three different levels of social presence: Full (f2f), medium online and low social presence (each $n = 20$). Participants had to solve an online puzzle in dyads.

Findings mainly confirm a favourable influence of social presence on the perception of task and collaboration. Additionally, this study supports the importance of considering the reciprocal nature of social presence.

1. Introduction

Previous studies identified several factors to influence successful online collaboration (Fussell et al., 1998; Lou, Abrami, & D'Apollonia, 2001). Among these factors are group cohesion and optimised coordination in groups. Gradually, social aspects, such as perception of belonging to a group or trusting group members, move into the centre of attention because they are essential for effective learning (Kreijns, Kirschner, & Jochems, 2003). Several pitfalls and obstacles have been identified (Kreijns et al., 2003) to influence groups' performance. Examples of such obstacles are social loafing in virtual groups, coordination complications, establishing and maintaining cognitive as well as social mechanisms like social interaction that is based on a sense of trust or being part of a team (Kreijns et al., 2003), which in turn will lead to more meaningful cognitive processes such as not interpreting critique as a personal attack.

Detailed insight into social presence provides understanding of how online collaboration can be supported better. Existing research often investigates factors that influence social presence. However, research findings are not always straight forward. Therefore, the below presented study examines the concept of social presence and takes it one step further by investigating its potential as a causing factor.

2. Theoretical background

While there are many elements within the social dimension, this work emphasizes social presence. Among researchers, presence is considered a crucial part of online environments (Whitelock, Romano, Jelfs, & Brna, 2000). Social presence is defined as the degree to which a person is aware of another person in a technology-mediated communication setting (Short, Williams, & Christie, 1976). Even though many more definitions have emerged since the work done by Short et al. (1976), they put a strong emphasis on the role technology plays for the concept. The current study emphasizes this importance as well and therefore takes up the definition by Short et al. (1976). Researchers have pointed to the importance of understanding individuals' perceptions in order to understand social presence (Hwang & Park, 2007). For example, the presence of a message sender influences the recipient's understanding and in turn influences intersubjective interpretation. Rourke, Anderson, Garrison, and Archer (1999) stress this by viewing social presence as the ability of participants to project themselves socially and emotionally in a community of inquiry. This study aims at the lack of research concerning the relationship of participants' individual differences in social presence perception and their experience within the field of computer-mediated collaboration. In order to shed further light onto the reasons why individuals experience social presence differently, three factors will be illuminated (Arrow, McGrath, & Berdahl, 2000): The task, the handling of the task and the medium, but also measures of the

* Corresponding author.
E-mail address: maria.bannert@phil.tu-chemnitz.de (M. Bannert).

individual such as motivation and attitude will be investigated in more detail.

In general, a larger body of research suggests that social presence is related to increased satisfaction (Gunawardena & Zittle, 1997; Hostetter & Busch, 2006; Richardson & Swan, 2003).

However, evidence can be found that a misfit between the medium and a task's social need can negatively influence the experience of social presence (Chou & Min, 2009) as well as communication performance (Mennecke, Valacich, & Wheeler, 2000). For example, simple tasks with unambiguous answers benefit from media which offer only low social presence, while judgement tasks require media which allow high social presence (Chou & Min, 2009). In addition, a larger body of research suggests that social presence is related to increased satisfaction (Gunawardena & Zittle, 1997; Hostetter & Busch, 2006; Richardson & Swan, 2003). This stresses the point that social presence influences the individuals' perception of online settings.

Lately, researchers have claimed that the direction of the relationship between social presence and related variables is not clear. In current research, social presence is often seen as either a cause or an influenced factor (Gunawardena, 1995; Wise, Chang, Duffy, & del Valle, 2004). Due to research diversity and to different operationalisations of measuring social presence in online collaboration, it is not clear whether the degree of social presence is to a greater extent influenced by participant variables or affects participant variables. For example, a participant's higher motivation could be on the one hand the result of more involvement which in turn leads to the experience of increased social presence. On the other hand a participant could be more motivated and involved because of a high amount of social presence experienced. This uncertainty of direction can also be found in research. For example, Short et al. look at social presence as the ability of a medium, whereas Rourke et al. view it as an ability of a learner. These are two very different perspectives that result in different operationalisations: The first looks at variations in different media settings whereas the latter looks at the individuals taking part in such a setting.

This experimental study pursues a detailed investigation of this relationship of dependence. It expands the concept of social presence by illuminating the potential of social presence as a causing factor. Indeed, former research in computer-supported collaboration shows that effects are not straightforward (Cress, 2005) and reciprocal effects might be at work.

So far, no research study has investigated the causal direction between social presence and related variables, such as media, tasks and members. The combination of both views on social presence will provide further guidance on the interpretation of today's research diversity concerning the concept of social presence.

The aim of this experimental study is to investigate both aspects further: The relation of social presence and the perception of task and medium, as well as the role of prior ICT and online media experience in online communication/collaboration.

3. Research questions and hypotheses

The research questions addressed by the study are derived from current research on social presence in the field of computer-mediated collaboration. As sketched above there is still a lack of research investigating participants' perceptions in order to understand the concept of social presence further. Moreover, there are unclear research findings into the causal relationship of social presence and related concepts.

3.1. Influence of social presence on the perception of the task

Even though the task itself does not directly influence the level of social presence experienced, this level might influence partici-

pants' perception of the task. This assumption acts under the presumption of an optimal task–medium fit, based on research findings, e.g. by Chou and Min (2009). An optimal task–medium fit is accomplished when a task's social need is met by the medium's potential to convey social presence: Simple tasks require media with low social presence conveyance and complex tasks require media with high social presence potential.

Hypothesis 1. The more sociable an environment, the less strenuous and threatening will a task be perceived. A high degree of social presence leads to a positive attitude towards the task.

3.2. Influence of social presence on the perception of the medium

Previous research found that the level of immediacy, i.e. how quickly a response is given to an action, leads to increased social presence levels (Weinel & Hu, 2007). Different media allow for different reaction times to a response and consequently, different levels of social presence are experienced according to the level of immediacy.

High levels of social presence have been found to result in high levels of perceived learning satisfaction and perceived satisfaction with the instructor (Richardson & Swan, 2003). Assuming that higher social presence levels lead to a less strenuous perception of the task, it will also lead to increased satisfaction with the medium.

Hypothesis 2. The higher the amount of perceived social presence, the higher the level of satisfaction with the online environment.

3.3. Influence of social presence on the perception of the collaboration

The level of social presence influences the perception of collaboration within the team. Lower levels of social presence can diminish communication quality (Roberts, Lowry, & Sweeney, 2006) and as a result influence the perception of the collaboration.

Hypothesis 3. The higher the amount of perceived social presence, the more favourable the collaboration is experienced.

3.4. Prior ICT and online media experience

The effects of social presence on the judgement of the task and the medium vary with the level of participants' prior ICT and online media experience. For example, a higher level of preexisting computer-expertise is related to a higher level of social presence experienced (Hostetter & Busch, 2006; Mykota & Duncan, 2007).

Hypothesis 4. The more participants are experienced with ICT and online media, the more easily will they experience social presence and therefore perceive the online environment, i.e. the medium, more favourable.

4. Method

4.1. Experimental Design

As shown by Yang, Chung, and Chien (2008) for asynchronous computer-mediated collaboration, providing an open communication environment can promote social presence. This concept was transferred to a synchronous communication environment and used to vary the amount of social presence experience within an online condition. Research argues that cues, such as sharing personal information, within computer-mediated collaboration,

manipulate the level of presence felt (Wise et al., 2004). Thus, the experimental design considers one independent variable: The sociability of the online environment is manipulated by three conditions (sociability in increasing order): 1. task-oriented online puzzling, 2. Social Presence Online puzzling, 3. face-to-face (f2f) puzzling, i.e. social presence f2f control group. Social presence is defined as the degree to which a person is aware of another person in a technology-mediated communication setting, therefore the face-to-face setting serves as a control condition, as this provides the most possible amount of cues.

Research described above suggests that the perceptions of the task as well as the medium are influenced by the amount of social presence experienced in online environments. As dependent variables the perception of task, task handling and task environment are measured by questionnaires. Items concerning the task aim at the estimation of the amount of cognitive strain the task poses on participants. Items concerning the task handling, target the collaborative aspect in the team work. Items concerning the task environment capture the perception of the medium. While task and task environment judgements aim more at a participants' perception of their individual experience, the variable task handling aims at the perception of the collaboration.

Participant's ICT experience and online media experience are also measured with questionnaires referring, by two aspects of pre-existing experience: 1. The ICT experience scale focuses on the general ability to handle computers and 2. The online media experience scale aims at the experience with online communication.

4.2. Participants

The study was conducted at the Technical University of Darmstadt, Germany and the University of Salzburg, Austria with 60 participants who were students at one of the two universities. The participants' age ranged between 20 and 43 years, with a mean of $M = 25.27$ (SD = 5.68). Out of the 60 participants, 49 were female (81.7%) and 11 were male (18.3%). We recruited each member of a team from different semesters to ensure that the members of a dyad did not know each other. This allowed for consistent comparison across dyads as we assumed that naturally participants with a higher level of intimacy would also create initial higher levels of social presence.

4.3. Procedure and task

As described above three conditions were examined in this study. Two conditions were conducted online and the third condition, the control group, was conducted in a face-to-face mode. The two online conditions differed in the amount of sociability: one condition was strictly task-oriented and the other had an additional social focus. The differing sociability was ensured through the instruction given at the beginning of the experiment. All conditions were initially the same, they varied only according to the given instruction.

To each of the three conditions 20 participants were randomly assigned. All were instructed and given a questionnaire. The instructor also talked them through the functionality of the online environment. The task took 30 min. Participants were informed that the task was too complex to be solved within 30 min and their goal was to achieve a solution as best as possible. Afterwards, all participants answered the second half of the questionnaire.

The task was to solve an online mouse puzzle in a dyad (see Fig. 1). Each of the team members had 8 cards with mouse heads and tails. Team members had to align matching colored heads and tails of a mouse. The puzzle could only be solved by using all 16 cards at once.
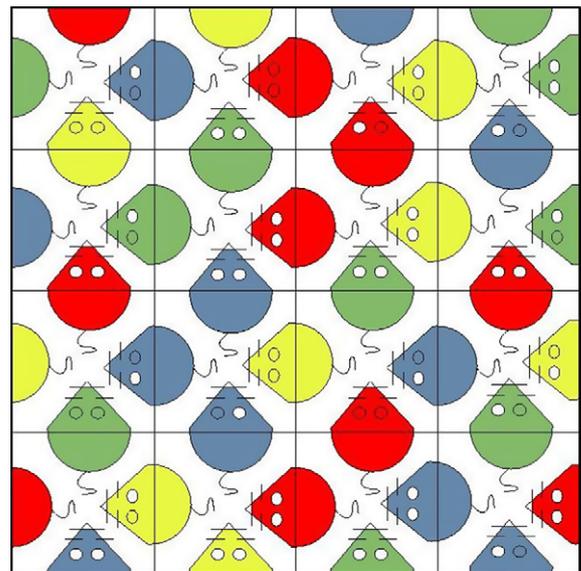

Fig. 1. Screenshot of a solution example to the mouse puzzle exercise.

The puzzle exercise was chosen as it provided a task with potential for mutual communication and negotiation. It was easy to comprehend and did not need a lot of explanation. The important point to stress about the task is that it asked for collaboration in order to accomplish the task. It needed to be complex enough to require interaction and easy to understand. The puzzle was implemented in a similar manner to studies conducted by Muehlenbrock (2004). The puzzle environment was adjusted and modified to this studies' specifics by the Collide Research Group of the University Duisburg-Essen, Germany. For the layout and functionality of the puzzle environment see Fig. 2.

Once the cards were placed in the public space they could be moved and rotated by both team members, but could not be placed back to the private area anymore. In order to develop and negotiate a common strategy, the two online conditions had the possibility to use a textbased chat, while participants in the control group were able to communicate face-to-face. The task-oriented online group was instructed to use the chat only for task-related topics while the socially-oriented online group was encouraged to use the chat freely.

4.4. Instruments

A number of different instruments were used to gather data in the experiment. The questionnaire was split in two: one part was administered before and one after the experiment. The questionnaire in the beginning was composed of two scales: General Task Attitude and Specific Task Attitude (see Table 1).

Both scales of the first questionnaire were derived, in a slightly changed format, from the instrument FAM (Fragebogen zur Erfassung aktueller Motivation in Lern- und Leistungssituationen ["Instrument to determine motivation during learning and performance tasks"] (Rheinberg, Vollmeyer, & Burns, 2001). The original instrument by Rheinberg et al. (2001) was composed of 18 items, measuring four different aspects of motivation during learning and motivation tasks. The four aspects are: failure orientation, success probability, engagement/interest and challenge. The scale General Task Attitude was composed of most of the FAM's items from the engagement and failure orientation scales. The Specific Task Attitude scale was composed of most items out of the success probability and challenge scales from the FAM.

The participants' judgement of the task, the task handling as well as the puzzle environment were assessed after the experi-
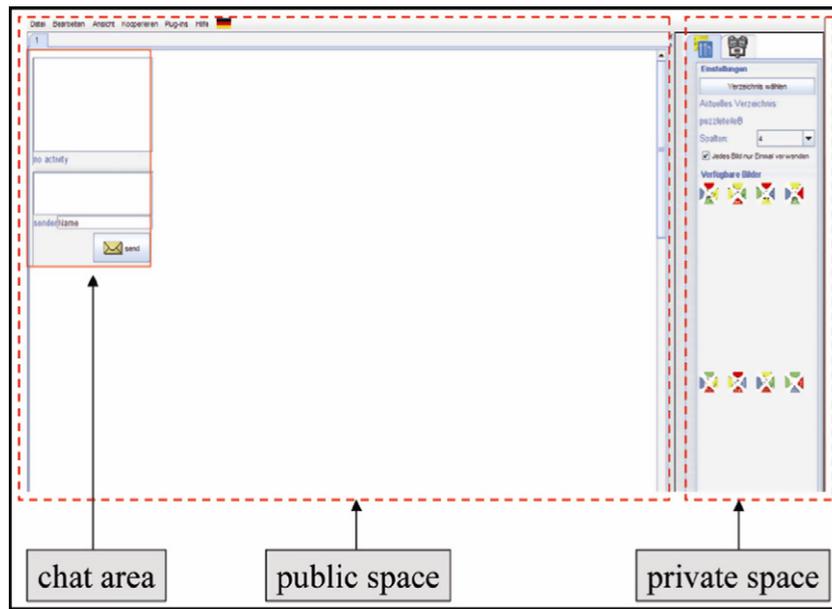
Fig. 2. Screenshot of the puzzle environment.

Table 1
Scales on General Task Attitude and Specific Task Attitude (administered before the experiment).

Scale	Items[*]	Value range
General Task Attitude (Final version: 9 items)	• "I like such tasks." • "I like the role as a scientist." • "I feel under pressure." • "The task seems interesting." • "Afraid to embarrass me." • "The task is fun." • "Embarassed to fail." • "Uneasy when thinking of the task." • "The requirements paralyze me."	1 (not true at all) to 7 (entirely true)
Specific Task Attitude (Final version: 7 items)	• "Can handle the difficulty of the task." • "Will not master the task." • "Excited to see how well I will do." • "Will make an effort." • "Anyone can solve a task like this." • "I cannot do this." • "Will be proud to solve the task."	1 (not true at all) to 7 (entirely true)

[*] Paraphrased only.

ment. Furthermore, their experience with ICT and online media were also asked at this point. The latter two served as covariates. Experience with ICT was composed of items from the ICT literacy instrument by Markauskaite (2005). One variable, Judgement of Online Environment, was calculated in two versions as only one version allowed for a proper comparison with the control group. This variable was composed of many questions concerning the communication in the online environment. Since the control group communicated face-to-face, the items in question were deleted for comparability reasons. The slimmed-down comparable version is called Judgement of Collaboration. For a detailed overview, see Table 2.

The operationalisation of all three variables to determine either the task, the medium or the interactive collaborative aspect was accomplished by drawing on research from earlier phases of our research. Items were derived from the pool of questions administered during an earlier study by Weinel and Hu (2007). The questions were slimmed down, since the original set of questions was developed for a long term course. The experimental study considered only relevant questions for the actual experimental setting.

For example, "How would you rate the difficulty of the task you have been working on during the last week?" was amended to "How strenuous was the puzzle task on you?".

5. Results

At first, the quality of instruments and implications for the variables are presented. Secondly, findings concerning social presence and its potential as a causing factor are presented. Finally, further light is shed onto the influence of experience with ICT and online media. Results for this study were calculated with SPSS 17.0 for Windows.

Due to technical problems the textbased chat data could not be restored and was lost in large parts to scientific investigation. Consequently, the possibility of triangulation was lost and a check if the instruction was induced as intended was lost as well. However, there is no indication that the chat data would have changed the results in any way. Furthermore, observations by the investigator during the experiment as well as informal discussions between participants and the investigator after the experiment indicated

Table 2
Scales on Judgement of Task, Task Handling, Online Environment and Collaboration as well as on Experience with Online Media and with ICT (Administered after the Experiment).

Scale	Items[*]	Value range
Judgement of Task (3 items)	• "I felt under stress during task." • "Level of mental activity drawn by the task." • "I felt under time pressure during task."	1 (none) to 5 (a lot)
Task Handling Judgement (4 items)	• "We established a common ground." • "Our communication suffered misunderstandings." • "I knew what my partner wanted." • "I was able to clearly state my ideas."	1 (do not agree at all) to 5 (agree entirely)
Judgement of Online Environment (10 items)	• "Our collaboration was successful." • "I enjoyed the collaboration." • "I felt like part of a group." • "The environment provided the possibility for social exchange." • "The environment provided the possibility to express feelings." • "The means of communication were sufficient." • "An online environment is a reliable communication medium." • "Task/online environment were threatening." • "We found an efficient way to work on the task." • "We made extensive use of chat."	1 (do not agree at all) to 5 (agree entirely)
Judgement of Collaboration (5 items)	• "Our collaboration was successful." • "I enjoyed the collaboration." • "The means of communication were sufficient." • "Task/online environment were threatening." • "We found an efficient way to work on the task."	1 (do not agree at all) to 5 (agree entirely)
Experience with Online Media[**] (2 items)	• "I have experience with e-mail." • "I have experience with chat."	1 (no experience) to 5 (very experienced)
Experience with ICT[**] (6 items)	• "Ability to handle computer and software." • "Ability to handle files and folders." • "Ability to surf in the internet." • "Ability to collect information on the internet." • "Ability to judge relevance and credibility of collected information from internet." • "Ability to publish media information on the internet."	1 (do not have this ability) to 6 (I am completely confident)

[*] Paraphrased only.
[**] Served as covariates.

that participants followed instructions. Such data was only gathered informally and holds no claim to be objective and theory-driven. The authors recommend to include that type of data in a theory-driven way in future experimental settings to allow for triangulation. Nevertheless, missing data triangulation surely imposes a limit on the current study and data can only be interpreted within this limitation. We ensured that the groups did not differ significantly before the start of the experiment, through randomisation. We also checked afterwards that groups did not differ significantly regarding their previous online media or ICT experience.

5.1. Instrument reliability

Most variables achieved a satisfactory reliability measure with a Cronbach's Alpha of $\alpha \geqslant .7$ (see Table 3). Three variables included items that needed to be deleted to achieve a more reliable scale: Specific Task Attitude, Task Judgment and Experience with online media.

5.2. Effects of social presence on perceptions of task, medium and collaboration

Descriptives for dependent variables with respect to experimental condition are presented in Table 4. The attitude towards tasks in online environments (General Task Attitude) was most positive during the Social Presence F2F treatment ($M = 4.97$, $SD = 1.00$), followed by Social Presence Online ($M = 4.95$, $SD = 0.91$) and finally the Task Oriented Online treatment ($M = 4.36$, $SD = 0.98$). The attitude towards the specific puzzle task (Specific Task Attitude) was most positive during the Social Presence Online treatment ($M = 4.95$, $SD = 0.55$), followed by Social Presence F2F ($M = 4.94$, $SD = 0.92$) and finally the least positive during the Task Oriented Online treatment ($M = 4.82$, $SD = 0.78$).

With only slight differences, participants judged the task more strenuous during the Task Oriented Online treatment ($M = 2.80$, $SD = 0.54$), followed by Social Presence F2F ($M = 2.78$, $SD = 0.59$). The task was judged least strenuous during the Social Presence On-

Table 3
Statistics and Reliability Measures (Cronbach's α) of Scales ($N = 60$).

Scale	N of items	M of scale	SD of scale	Cronbach's α
General Task Attitude	9 items	32.43	7.55	.78
Specific Task Attitude	7 items	34.30	5.41	.62
Judgement of Task	3 items	7.35	2.34	.70
Task Handling Judgement	4 items	15.50	3.41	.83
Judgement of Online Environment	10 items	34.28	6.76	.81
Judgement of Collaboration[*]	5 items	18.68	3.92	.79
Experience with Online Media[**]	2 items	8.28	1.62	.66
Experience with ICT[**]	6 items	23.58	4.86	.87

[*] Comparable version of Judgement of Online Environment: items aiming at online communication were deleted.
[**] Served as covariates.

Table 4
Descriptives for dependent variables for each experimental condition.

		N	Min	Max	M	SD
General Task Attitude	Task Oriented Online	20	2.67	5.78	4.36	0.98
	Social Presence Online	20	2.56	6.33	4.95	0.91
	Social Presence F2F	20	3.00	6.89	4.97	1.00
Specific Task Attitude	Task Oriented Online	20	2.29	6.14	4.82	0.78
	Social Presence Online	20	3.86	5.86	4.95	0.55
	Social Presence F2F	20	2.71	6.57	4.94	0.92
Judgement of Task	Task Oriented Online	20	2.00	3.75	2.80	0.54
	Social Presence Online	20	1.25	4.25	2.76	0.77
	Social Presence F2F	20	1.75	3.75	2.78	0.59
Task Handling Judgement	Task Oriented Online	20	1.60	5.00	3.85	0.92
	Social Presence Online	20	1.80	5.00	3.76	0.86
	Social Presence F2F	20	3.40	5.00	4.43	0.41
Judgement of Online Environment	Task Oriented Online	20	2.40	4.80	3.46	0.68
	Social Presence Online	20	1.90	4.90	3.40	0.69
Judgement of Collaboration	Task Oriented Online	20	2.60	5.00	3.72	0.75
	Social Presence Online	20	1.80	5.00	3.39	0.87
	Social Presence F2F	20	3.20	5.00	4.25	0.49

line treatment ($M = 2.76$, $SD = 0.77$). Among the two online conditions, participants judged the online environment (Judgement of Online Environment) more positive during Task Oriented Online treatment ($M = 3.46$, $SD = 0.68$) compared to Social Presence Online ($M = 3.40$, $SD = 0.69$). The task handling (Task Handling Judgement) was judged most positively during the Social Presence F2F treatment ($M = 4.43$, $SD = 0.41$), followed by the Task Oriented Online treatment ($M = 3.85$, $SD = 0.92$) and the Social Presence Online treatment ($M = 3.76$, $SD = 0.86$).

Similarly, the collaboration (Judgement of Collaboration) was judged most positively during the Social Presence F2F treatment ($M = 4.25$, $SD = 0.49$), followed by the Task Oriented Online treatment ($M = 3.72$, $SD = 0.75$). The least positive did participants judge their collaboration during the Social Presence Online treatment ($M = 3.39$, $SD = 0.87$).

Furthermore, Table 4 presents descriptives for two single items that are carried over for relevance reasons. Participants judged their task solution as more successful during the Social Presence F2F ($M = 3.00$, $SD = 0.80$), followed by the Task Oriented Online treatment ($M = 2.65$, $SD = 0.93$). The least successful was the task solution judged during the Social Presence Online treatment ($M = 2.25$, $SD = 0.80$). Furthermore, participants felt they could express their feelings best during the Social Presence F2F treatment ($M = 4.35$, $SD = 081$); both online conditions did not differ, participants perceived them as being less able to express their feelings Social Presence Online ($M = 3.45$, $SD = 1.15$) and Task Oriented Online ($M = 3.45$, $SD = 1.05$).

In order to test for significant differences between treatment groups, inferential statistics were applied. In a first step, all dependent variables were tested for normal distribution of values. Results of the "One-Sample Kolmogorov–Smirnov Test" showed that all but one variable did not differ statistically significant from a normal distribution. For these variables, the prerequisite for the application of parametrical test procedures was given. Only one variable, Judgement of Task Handling, was not distributed normally and non-parametrical test procedures were applied here. Another prerequisite for the application of parametrical tests is the homogeneity of variances. Only one variable revealed significantly different variances: Judgement of Collaboration (the shorter, comparable version of the participants' Judgement of Online Environment). To Judgement of Collaboration, non-parametric tests were applied as well. The complete version of the scale Judgement of Online Environment was considered separately, since it was only answered by the two online groups.

The ANOVA for the three qualifying variables revealed only a significant influence for the General Task Attitude ($F(2, 57) = 2.50$,

p (one-tailed) = .05, $\eta^2 = .08$). The other two variables showed no significant influence of the online environment's sociability on the attitude towards this specific puzzle task (Specific Task Attitude) ($F(2, 57) = .17$, p (one-tailed) = .42, $\eta^2 = .01$) or the Judgement of the Task ($F(2, 57) = .02$, p (one-tailed) = .49, $\eta^2 = .00$).

General Task Attitude is only significant at the one-tailed level ($p = .046$). Means for General Task Attitude in each of the conditions hint to the fact that both groups with the possibility for social exchange, online and face-to-face, differ from the task-oriented group. This again provides only partial support for Hypothesis 1.

The ANOVA for Judgement of Online Environment revealed no statistically significant differences between groups ($F(1, 38) = 0.09$, p (one-tailed) = .40, $\eta^2 = .00$). This does not support Hypothesis 2.

Non-parametric tests for both qualifying variables, Task Handling Judgement ($\chi^2(2) = 8.51$, $p = .01$) and Judgement of Collaboration ($\chi^2(2) = 11.48$, $p = .00$), indicated a statistically highly significant difference among the three levels of social presence. The Kruskal–Wallis test indicated for both variables the lowest mean rank during the social presence online condition (Task Handling Judgement: $M = 24.70$; Judgement of Collaboration: $M = 22.70$). The social presence face-to-face condition (control group) received the highest rank (Task Handling Judgement: $M = 39.60$; Judgement of Collaboration: $M = 40.83$), see also Table 5.

Post hoc tests for both variables confirmed Hypotheses 3 only partially. Based on the Mann–Whitney U measure, both variables revealed significant differences between online conditions and the face-to-face condition. The social presence online condition and the social presence face-to-face condition differed significantly (Task Handling Judgement: $U = 100.50$, $p = .01$; Judgement of Online Collaboration: $U = 83.00$, $p = .00$). Furthermore, both variables revealed a difference between the task oriented and the social presence face-to-face condition (Task Handling Judgement: $U = 117.50$, $p = .02$; Judgement of Online Collaboration: $U = 110.50$, $p = .01$). This confirms hypothesis 3 only partially.

5.3. Covariates: ICT and online media experience

The correlational analysis for ICT and online media experience and the dependent variables revealed a relationship between them (see Table 6). Experience with ICT correlated positively with the perception of task aspects. The more experienced someone was with ICT, the less they felt under pressure to perform well (General Task Attitude) ($r = .33$, $p = .01$). After task completion, they were also the ones to judge the task as less strenuous (Task Judgement) ($r = -.24$, $p = .03$).

Table 5
Overview of non-parametric test results (Kruskal–Wallis test) for both not normally distributed variables Judgement of Collaboration and Task Handling Judgement.

	Condition	N	Mean rank
Task Handling Judgement	Task Oriented Online	20	27.20
	Social Presence Online	20	24.70
	Social Presence (F2F)	20	39.60
Judgement of Collaboration	Task Oriented Online	20	27.98
	Social Presence Online	20	22.70
	Social Presence (F2F)	20	40.83
Test statistics[a,b]			
	Chi-Square	df	Asymp. Sig.
Task Handling Judgement	8.51	2	.01
Judgement of Collaboration	11.48	2	.00

[a] Kruskal–Wallis Test.
[b] Grouping variable: Condition.

The experience with online media revealed a slightly different connection to the dependent variables (see Table 6). It was connected to all three types of dependent variables: task, media and collaboration. The more participants were experienced with online media, the less they felt under pressure to perform well [General Task Attitude] ($r = .32$, $p = .01$), the more favourable they judged the online environment [Judgement of Online Environment] ($r = .25$, $p = .03$) and the more positively they perceived their collaboration [Task Handling Judgement] ($r = 28$, $p = .02$). The prior experience with ICT or online media was not connected at all to the specific task judgement, which captured the attitude towards the puzzle task.

A subsequent covariance analysis with prior ICT experience or online media experience in dependence with varying social presence revealed no significant influence on any of the four dependent variables. This does not support Hypotheses 4.

6. Discussion

6.1. Social presence as a causal factor

The task at hand proved to be complex enough to require collaboration but not too complex for participants to undergo a lengthy training process. The results are limited to that type of task and should be interpreted with that limitation in mind.

Results provide insights into the relationship between task and social presence. Findings revealed that social presence influences the participants' attitude towards the task. Interestingly, when asked directly after the instruction about their general task attitude, participants in the two social conditions expressed less pressure and less unease than participants in the task-oriented condition. The initial lower levels of stress for social conditions may be explained by participants' expectation to freely converse with their peers and thus find help. However, after task completion, this difference disappeared and all three conditions reported equal levels of cognitive strain caused by the task; supporting Hypothesis 1 only partially. This finding illuminates the complex

role of social exchange in communication: Expectations towards social exchange are mostly based on the experience with face-to-face communication. However, online communication differs from this form of communication in various ways. The study pointed to this gap between expectations and online experience. This confirms conclusions from an earlier study (Weinel and Hu, 2007), ambiguity and uncertainty in online communication can be minimised through the use of chat protocols and norms. More research is needed to determine how such rules can influence the perceived quality of the communication.

These findings could also be explained by considerations from Wise et al. (2004): Social presence is a variable with some kind of threshold and it is important to exceed a critical level. In order for it to alter participants' perceptions or interactions, participants need to feel a certain level of someone else's involvement. Participants of both online conditions experienced a form of involvement in different ways: (1) through communication in the chat and (2) by watching the movement of puzzle pieces done by their teammate.

Such findings support and extend research (e.g. Rourke et al., 1999; Swan, 2003) contradicting the notion of social presence as a capability of the medium itself, as introduced initially by Short et al. (1976). Participants found other ways to convey social presence than the medium's abilities and judged the involvement of their team member, e.g. by movement of puzzle pieces. Interactive responses are one way to convey social presence (Rourke et al., 1999). The greater the immediacy, the greater the social presence felt. Another way is the use of emoticons or verbal expressions to introduce intimacy into text-based communication.

Furthermore, the medium as well as the collaborative aspect were affected most distinctly by the amount of social presence experienced. Participants favoured communication in a face-to-face setting over the communication in the online environment. They judged the communication as more successful, enjoyed the collaboration more and were of the opinion that they found an efficient way to solve the task. Even though there was a trend within the two online conditions for the task-oriented condition to have a more positive effect on the judgement of the medium, this trend was not statistically significant. Again, this supports threshold considerations by Wise et al. (2004). They reported that even though both groups experienced different levels of social presence, they still perceived the messages as friendly and positive.

The above stated arguments receive further support through the finding that participants in both online conditions felt they could express their feelings equally well. The study showed no difference between the online conditions, while revealing differences between the online conditions and the face-to-face condition. Participants in the control group felt they could express their ideas more clearly.

The above stated arguments continue findings from earlier studies by Weinel and Hu (2007). These findings showed that the level of social presence experienced within a medium in the experimental study did not lead to differences in the perception of the medium itself. While the difference in social presence (face-to-face

Table 6
Correlations between ICT and online media experience with dependent variables ($N = 60$).

		General Task Attitude	Specific Task Attitude	Task Judgement	Task Handling Judgement	Judgement of Collaboration
Experience with Online Media	Pearson Correlation	.32	.08	−.16	.28	.25
	Sig. (1-tailed)	.01	.27	.12	.02	.03
Experience with ICT	Pearson Correlation	.33	.07	−.24	.11	.11
	Sig. (1-tailed)	.01	.31	.03	.20	.21

vs. online) across media led to different perceptions of a medium, the variations within one particular medium were not strong enough to alter the perception. This leads to the assumption that the concept of social presence is a stronger predictor of behaviour when looking at differences across media, as opposed to variations within one medium. It supports the idea of a threshold that has to be overcome in order to have any effect (Wise et al., 2004). Apparently, the variation of social presence within one medium is not strong enough to overcome this threshold. This is different across media, and the effect of social presence can be measured. Again, these findings support Hypothesis 2 only partially.

Furthermore, the interaction was also perceived differently among the groups. Participants judged the handling of the task more favourable during the face-to-face condition, compared to the online conditions. A trend among the online conditions crystalized, pointing to the lesser of the two social presence conditions being favoured. While this trend did not show to be statistically significant, it could possibly be explained by findings concerning the proper task-media fit (Chou & Min, 2009; Mennecke et al., 2000). Possibly, the task did not inherit the amount of social interaction that was intended by the author. As already stated above, it might have been sufficient for participants to follow the movements of the puzzle pieces to gain a feeling of social presence through this measure of involvement. This would lead to the conclusion that the optimal task–medium fit in this case would be found when only discussing the task and not considering personal information.

Finally, while earlier research found that different media convey different levels of social presence (e.g. Weinel and Hu, 2007), the current study revealed that increased levels of social presence also influence the perception of the medium. Furthermore, earlier research did not reveal an influence of the task on social presence. However, as shown in the experimental study, different levels of social presence alter the perception of the task. Furthermore, social presence influences the perception of group interactions, which in turn have been found to influence the social presence experienced (e.g. Wise et al., 2004). Such findings underline the complex nature of social presence. In order to understand the concept and its impact as well as the influence it is prone to, a variety of considerations are of importance.

The experimental study is a good example to show that seemingly contradictory views of social presence can provide explanations to the concept at different levels. For one, Short et al.'s (1976) view on social presence as a medium's ability can provide insight into the optimal fit of task and medium. Secondly, the social perspective on social presence as a participant's potential delivers insights into the complex causal relationships of the concept and explains participants' potential to adapt to certain media.

6.2. Relevance of ICT and online media experience

Results revealed no statistically significant connection between prior experience of ICT and online media as a covariate to social presence affecting the task, medium or collaboration aspect.

However, correlations revealed a connection between prior experience and the three aspects of task, media and collaboration. While ICT experience was linked more closely to task aspects, the experience with online media was linked to all three aspects. The more experienced participants were with ICT and online media, the more they had a positive general attitude towards working in an online environment and the more favourable they judged the medium as well as the collaboration.

Concluding from these findings, the effects on social presence that have been found in former research (Hostetter & Busch, 2006; Mykota & Duncan, 2007; Wise et al., 2004) were more closely related to the experience with online media than the experience with ICT in general. Most of the research reported findings concerning former online course participation. This leaves to conclude that the more often participants experience the same situation, the more they experience social presence. This conclusion is also supported by research into social presence time patterns, which found that social presence in a group increases over time (e.g. Picciano, 2002).

Considering the definition of social presence as a participant's potential, this would mean that such a potential is not a fixed ability but can be trained over time. This is an important finding for understanding social presence. Some research already points to the fact that introducing participants to the concept of social presence alters their experience in a positive way. The above stated findings support and expand current research findings and hint to the fact that the introduction of social presence as a concept to online collaborators can be beneficial to its experience in online settings.

Despite the fact that the findings do not support Hypothesis 4 and the experience of social presence might be independent of prior experience, it still seems to play an important role in the experience of online communication. Further research needs to be conducted to better understand the connection between prior experience and the perception of interaction in an online setting.

7. Conclusion

The experimental study revealed the influence of social presence on participants' perception of the medium and the interaction. It also supported research considerations into the optimal fit of task and medium. In addition, findings illustrate a different perspective of social presence: the idea of a threshold (Wise et al., 2004).

Findings also revealed that prior experience with online media is more closely linked to the concept of social presence than ICT experience in general. Presuming the definition of social presence as a participant's potential, this leads to the conclusion that social presence can be trained and in such a way teachers can positively influence participants' experience in an online setting.

The integration of findings from earlier research by Weinel and Hu (2007) and this experimental study delivers new insights into the reciprocal nature of social presence and associated concepts. Most of the investigated variables, e.g. the medium, are often influenced by the experience of social presence and this in turn influences participants perception of that same exact variable. These findings address a lack of research into the causal nature of social presence that the authors believe to be reciprocal.

Overall, this highlights the concept's complex nature and stresses the importance to not only consider it as a cause but also as an influenced variable in online settings. The concept of social presence is interwoven with a variety of variables, that are important to be considered in online settings; it plays an integral part in understanding dynamics in such an environment.

Due to technical problems, text-based chat data could not serve as a basis for a manipulation check, the missing data triangulation poses a limit to the interpretation of the study. However, concluding discussions between participants and the investigator hint at the circumstance that participants followed instructions. This fact in close consideration with research done by Wise et al. (2004), that sharing personal information within computer-mediated collaboration manipulates the level of presence felt, provides a good foundation for this further investigation of social presence as a causal factor.

References

Arrow, H., McGrath, J. E., & Berdahl, J. L. (2000). *Small groups as complex systems*. Thousand Oaks, California, USA: Sage Publications, Inc..

Chou, S.-W., & Min, H.-T. (2009). The impact of media on collaborative learning in virtual settings: The perspective of social construction. *Computers and Education, 52*(2), 417–431.

Cress, U. (2005). *Why member portraits can undermine participation.* Paper presented at the Computer Supported Collaborative Learning (CSCL), Taipei, Taiwan.

Fussell, R. S., Kraut, R. E., Lerch, F. J., Scherlis, W. L., McNally, M. M., & Cadiz, J. J. (1998). *Coordination, overload and team performance: Effects of team communication strategies.* Paper presented at the CSCW, Seattle, Washington, USA.

Gunawardena, C. N. (1995). Social presence theory and implications for interaction and collaborative learning in computer conferences. *International Journal of Educational Telecommunications, 1*(2/3), 147–166.

Gunawardena, C. N., & Zittle, F. J. (1997). Social presence as a predictor of satisfaction within a computer-mediated conferencing environment. *American Journal of Distance Education, 11*(3), 8–26.

Hostetter, C., & Busch, M. (2006). Measuring up online: The relationship between social presence and student learning satisfaction. *Journal of Scholarship of Teaching and Learning, 6*(2), 1–12.

Hwang, H. S. & Park, S. B. (2007). *Being together: user's subjective experience of social presence in CMC environments.* Paper presented at the conference of human-computer interaction: interaction design and usability, Beijing, China.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behavior, 6*(1), 335–353.

Lou, Y., Abrami, P. C., & D'Apollonia, S. (2001). Small group and individual learning with technology: A meta-analysis. *Review of Educational Research, 71*(3), 449–521.

Markauskaite, L. (2005). *From a static to dynamic concept: A model of ICT literacy and an instrument for self-assessment.* Paper presented at the 5th IEEE international conference on advanced learning technologies (ICALT 2005), Kaohsiung, Taiwan.

Mennecke, B. E., Valacich, J. S., & Wheeler, B. C. (2000). The effects of media and task on user performance. A test of the task-media fit hypothesis. *Group Decision and Negotiation, 9*(6), 507–529.

Muehlenbrock, M. (2004). Shared workspaces: Analyzing user activity and group interaction. In H. U. Hoppe, M. Ikeda, H. Ogata, & F. W. Hesse (Eds.), *New technologies for collaborative learning.* Dordrecht, Netherlands: Kluwer Academic Press.

Mykota, D., & Duncan, R. (2007). Learner characteristics as predictors of online social presence. *Canadian Journal of Education, 30*(1), 157–170.

Picciano, A. G. (2002). Beyond student perceptions: Issues of interaction, presence and performance in an online course. *Journal of Asynchronous Learning Networks, 6*(1), 21–40.

Rheinberg, F., Vollmeyer, R., & Burns, B. D. (2001). *FAM – Fragebogen zur Erfassung aktueller Motivation in Lern- und Leistungssituationen [Instrument to examine current motivation in learning and performance situations.].* USA: Universität Potsdam, Michigan State University.

Richardson, J. C., & Swan, K. P. (2003). Examining social presence in online courses in relation to students' perceived learning and satisfaction. *Journal of Asynchronous Learning Networks, 7*(1), 68–88.

Roberts, T. L., Lowry, P. B., & Sweeney, P. D. (2006). An evaluation of the impact of social presence through group size and the use of collaborative software on group member "voice" in face-to-face and computer-mediated task groups. *IEEE Transactions on Professional Communication, 45*(2), 223–247.

Rourke, L., Anderson, T., Garrison, R., & Archer, W. (1999). Assessing social presence in asynchronous text-based computer conferencing. *Journal of Distance Education, 14*(2).

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications.* London, UK: John Wiley.

Swan, K. P. (2003). Learning effectiveness: What the research tells us. In J. Bourne & J. C. Moore (Eds.), *Elements of quality online education, practice and direction* (pp. 13–45). Needham, MA, USA: Sloan Center for Online Education.

Weinel, M., & Hu, C. (2007). *Social presence and student perceptions in the blend of synchronous and asynchronous communication forms.* Paper presented at the 7th IEEE International Conference on Advanced Learning Technologies (ICALT).

Whitelock, D., Romano, D. M., Jelfs, A., & Brna, P. (2000). Perfect presence. What does this mean for the design of virtual learning environments? *Education and Information Technologies, 5*(4), 277–289.

Wise, A., Chang, J., Duffy, T., & del Valle, R. (2004). The effects of teacher social presence on student satisfaction, engagement and learning. *Journal of Educational Computing Research, 31*(3), 247–271.

Yang, J. T., Chung, I.-F., & Chien, S.-Y. (2008). *An* experimental study on community of inquiry. Retrieved from http://hdl.handle.net/2377/11049.