Group Awareness of Social and Cognitive behavior in a CSCL Environment

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Abstract: This study investigated whether a peer feedback tool and a reflection tool would enhance group performance in a computer-supported collaborative learning environment. The underlying assumption was that group performance can be positively influenced by making group members aware of how their social and cognitive behavior is perceived by themselves, their peers, and the group as a whole. Participants were 120 fourth-year high school students working, with or without the tools, in dyads, triads and groups of 4 on a collaborative writing task. Results show that groups using tools perceived their team as being better developed, experienced higher levels of group satisfaction and lower levels of conflicts, than groups not using the tools. Results demonstrate that awareness, stimulated by peer assessment and reflection tools, enhances the social performance of a CSCL-group.

Introduction

Collaborative learning, often supported by computer networks (computer supported collaborative learning, CSCL) is enjoying considerable interest at all levels of education. Collaborative learning, defined as the "mutual engagement of participants in a coordinated effort to solve the problem together" (Rochelle & Teasley, 1995, p. 70) has, among other things, been found to enhance the learners' cognitive performance (Johnson & Johnson, 1999) and to stimulate them to engage in knowledge construction (Stahl, 2004). The rapid development of information and communication technologies (ICT), has led to many computer applications (e.g., e-mail, chat, discussion forums, video conferencing, simulations, 3-D models, visualizations and external representations) which have proven to be useful tools or widgets to support collaborative learning (Janssen, Erkens, Kanselaar, & Jaspers, 2007).

Several researchers report cognitive and social benefits for groups in CSCL environments as compared to contiguous (i.e., face-to-face) groups. With respect to cognitive aspects of collaboration, researchers have found that students working in CSCL-environments report higher levels of learning (Hertz-Lazarowitz & Bar-Natan, 2002), make higher quality decisions, deliver more complete reports, participate more equally (Fjermestad, 2004; Janssen, Erkens, Kanselaar, & Jaspers, 2007), and engage in more complex, broader, and challenging discussions (Benbunan-Fich, Hiltz, & Turoff, 2003) than do students working face-to-face. With respect to social aspects, students working in CSCL-environments report higher levels of satisfaction compared to students in contiguous groups (Fjermestad, 2004).

There are, however, also contradictory results. Concerning the cognitive aspects of collaboration, students working in CSCL-environments sometimes perceive their discussions as more confusing (Thompson & Coovert, 2003), less productive (Straus, 1997; Straus & McGrath, 1994) and needing more time to reach consensus and make decisions (Fjermestad, 2004) than students working face-to-face. Also, students in CSCL-environments have been found to show lower levels of participation (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003), and to experience higher levels of conflict (Hobman, Bordia, Irmer, & Chang, 2002), lower levels group cohesiveness (Straus, 1997; Straus & McGrath, 1994) and lower levels of satisfaction (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). In other words, students working in CSCL-environments do not always reach their full potential. Two important reasons for the disparity between the potential of groups working in CSCL-environments and their performance lies in (1) the design of the CSCL-environment, and (2) the social and cognitive behavior of the group members.

With respect to design, CSCL environments often concentrate on functionality, focussing on the cognitive processes needed to accomplish a task and/or solve a problem (Kreijns & Kirschner, 2004). These functional CSCL environments coerce (Kirschner, Beers, Boshuizen, & Gijselaars, 2008) group members to limit their actions to cognitive processes to the detriment of socio-emotional processes. These socio-emotional processes, which are the basis for group forming and group dynamics, are essential for developing strong social relationships, strong group cohesiveness, feelings of trust, and a sense of community among group members (i.e., for creating a sound social space). Without such a sound social space, the group will not reach its full potential (Jehng, 1997). Groups in CSCL environments that lack social functionalities will ultimately perform poorly (e.g., Kreijns & Kirschner). For instance, despite technological advances, most CSCL still use text-based computer mediated communication (CMC) systems based on email, chat and/or discussion boards, which cannot easily convey visual nonverbal cues (Kreijns, Kirschner, & Jochems, 2003). The absence of these cues can

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cause specific problems for effective communication and interaction between group members since this removes possibilities for exchanging socio-emotional and affective information, and decreases information about group members' presence, self-image, attitudes, moods, actions and reactions (Short, Williams, & Christie, 1976). According to Short et al. the functions of these nonverbal cues are in some way related to forming, building or maintaining social relationships. Therefore, CMC can have negative effects on impression formation and group members' social behavior (e.g. Garton & Wellman, 1995; Walther, Anderson, & Park, 1994).

Second, group members form interpersonal perceptions during interaction (Kenny, 1994). Based on what they see and experience, they form impressions (e.g., norms, values, beliefs) about themselves, the group, other group members, and what the other group members think of them. These self-, other- and meta-perceptions are based on the cognitive behaviors (e.g., productivity) and social behaviors (e.g., dominance and friendliness) that they perceive during interaction. Based upon these perceptions, group members determine their own social and cognitive behavior, and develop social relationships with each other. However, research has shown that group members' perceptions of their own performance (i.e., self-perception) and of group performance are generally unrealistically positive, resulting in an illusion of group productivity (Stroebe, Diehl, & Abakoumkin, 1992). This tendency to believe that their group is performing effectively, while it often is not, can result in a reduction of effort by group members, a phenomenon also known as social loafing (Williams, Harkins, & Latané, 1981), which further undermines the groups' social and cognitive performance. However, group members are often not aware that they are loafing, or are unwilling to admit to it (Karau & Williams, 1993).

To overcome this obstacle to social and cognitive performance, CSCL environments can be augmented with computer tools or widgets that act as social contextual facilitators relevant for the learner's social interaction (Kirschner, Strijbos, Kreijns, & Beers, 2004). These tools, also known as 'social affordance devices', can positively affect social and cognitive performances in a CSCL environment (Kirschner, et al., 2004). Two operationalizations of such tools are used in this research, namely a peer feedback tool to make group members aware of the social and cognitive behavior of themselves, their peers, and how this is perceived by others, and a reflection tool to stimulate group members to reflect upon their individual behavior, why their peers see them the way they do, and to also reflect collaboratively (i.e., co-reflect) on the performance of the group as a whole. The aim of these tools is to make group members aware of their social and cognitive behavior and to enhance their social and cognitive performance and that of the group. The next sections deal with aspects central to these tools, namely peer feedback and reflection.

Peer feedback

Feedback can be described as information provided to an individual to increase performance (Kluger & DeNisi, 1996). In a learning situation, this information can come from many sources such as teachers, computers, fellow students, and so forth. This study centers on peer feedback; information provided by fellow learners which is intended to increase performance. This information can be provided on the outcome performance (i.e., outcome feedback), or on how one is performing (i.e., process feedback). Feedback can be given by individuals or groups, and can also be received by individuals or groups. In this study, peers provide process feedback at individual and group level, in order to enhance interpersonal behavior. It is expected that enhancement of interpersonal behavior will have a positive effect on a group's social performance (Geister, Konradt, & Hertel, 2006; McLeod & Liker, 1992; Phielix, Prins & Kirschner, in press), as well as an indirect positive effect on a group's cognitive performance (Kreijns, Kirschner, & Jochems, 2003).

Process feedback can include cognitive or task-related information (e.g., task behaviors, actions and strategies), or social or non-task related information, such as information about interpersonal behavior (e.g., dominance and friendliness) or teamwork (Geister, Konradt, & Hertel, 2006). McLeod and Liker (1992) found that process feedback at the group level on the interpersonal behavior of student group members, such as dominance and group orientedness, changed the dominance behavior of individual group members. Two other studies investigating individualized peer feedback on interpersonal behavior of group members (e.g., communication and collaboration), found that such feedback led to increased cooperation, communication, satisfaction and motivation in group members (Dominick, Reilly, & McGourty, 1997; Druskat & Wolff, 1999).

Based upon these ideas, an individualized peer feedback tool (Radar) was developed and studied in which group members individually provide information about the social and cognitive behavior of themselves, their peers, and the group as a whole. The premise behind this tool is that it will positively alter the social and cognitive behavior of individuals and group. Because group members tend to overestimate their social and cognitive behavior (Kenny, 1994), this peer feedback tool also included the peer perspectives on the social and cognitive behavior of themselves, their peers and the group as a whole. This information should be gathered by use of a self and peer assessment, and based on specific traits because there is strong evidence that peer perceptions are formed by unconscious or tacit 'rating' of other group members on several traits, such as 'dominance', 'friendliness' and 'reliability' (Brok, Brekelmans, & Wubbels, 2006).

Reflection

Simply providing group members' with information on their cognitive and social behavior is not enough to positively alter their behavior (Prins, Sluijsmans, & Kirschner, 2006). Group members also need to process this information and ask themselves whether they understand, accept, and agree with the feedback. In other words, they must reflect upon the feedback. Reflection is the intellectual and affective activities individuals engage in to explore their experiences (e.g., behaviors, ideas, feelings) in order to reach new understandings and appreciations (Boud, Keogh, & Walker, 1985). The feedback receiver needs to be challenged to reflect on his/her own performance, and determine whether the feedback provides clues for behavioral change (Prins, Sluijsmans, & Kirschner, 2006). Therefore, it is expected that peer feedback in combination with reflection will even be more effective than feedback alone (e.g., Schön, 1987).

According to Boud, Keogh, and Walker (1985), reflection can lead to new perspectives on experience, changes in behavior, readiness for application, and commitment to action. Therefore, reflection on peer feedback should make group members more aware of their own individual behavior, how their behavior affects others, and whether they should alter their behavior. Awareness can be defined as the "understanding of the activities of others, which provides a context for your own activity" (Dourish & Bellotti, 1992, p. 107). In order to make the group aware of its behavior, group members need to reflect collaboratively (co-reflect) on their cognitive and social performance. Co-reflection is defined as "a collaborative critical thinking process involving cognitive and affective interactions between two or more individuals who explore their experiences in order to reach new intersubjective understandings and appreciations" (Yukawa, 2006; p. 206).

Based upon these ideas, a shared reflection tool (Reflector) was developed and studied in which group members individually reflect and provide information on (1) their own individual perspective on their personal performance, (2) differences between their self perception and the perception of their peers concerning their personal performance, (3) whether they do or do not agree with the perceptions of their peers concerning their personal performance, and (4) their own individual perspective on group performance. Because group performance is determined by the individual effort of all group members, this tool also (5) stimulates group members to collaboratively reflect (co-reflect) on the group performance and reach a shared conclusion about this. Based on their shared conclusion, group members will (6) set goals in order to improve group performance.

Research Questions

This study investigated whether a peer feedback tool and a reflection tool would enhance group performance in a CSCL-environment. To this end, an existing CSCL-environment was augmented with two independent, but complementary, tools. The first was an individualized peer feedback tool - Radar - which was meant to stimulate and provide group members with information about the social and cognitive behavior of themselves, their peers, and the group as a whole. This information was presented from both the perspectives of the group members themselves (i.e., self perceptions), their peers (i.e., peer perceptions) and the group as a whole. The second tool was a shared reflection tool - Reflector - which was meant to stimulate group members to reflect on and provide information about their own behavior and how this behavior was perceived by their peers, their personal perspectives on the group's performance, as well as to co-reflect on the group performance and reach shared understanding on this.

The following research questions will be addressed:

1) Do groups with Radar and Reflector perform better socially than groups without Radar and/or Reflector? In other words, do groups using Radar and Reflector develop better, have higher group satisfaction, experience lower levels of group conflict, and a have more positive attitude towards collaborative problem solving than groups without Radar and/or Reflector?

    Expected is that both Radar and Reflector will positively affect the social behavior in the group, leading increased social performance of the group. A combination of the both tools should be most effective.

2) Do groups with Radar and Reflector perform better cognitively than groups without Radar and/or Reflector? In other words, do groups with Radar and Reflector produce a group product of higher quality than groups without Radar and/or Reflector?

    Expected is that both Radar and Reflector will positively affect the social behavior in the group and that this should indirectly lead increased cognitive performance of the group, A combination of both tools should be most effective.

Method
Participants

Participants were 120 fourth-year students (66 male, 54 female) from an academic high school in The Netherlands. Students came from four classes and were enrolled in the second stage of the pre-university education track which encompasses the final three years of high school. Prior to the experiment, the participating students were randomly assigned by the teacher to dyads, triads and groups of four, and randomly

assigned by the teacher to one of the three conditions (see Design). Therefore, group compositions were heterogeneous in ability and gender.

Design

For this study two experimental conditions and one control condition were used. The first experimental condition ($n = 69$) received the tools at the beginning (T1), halfway (T2) and at the end (T3) of the collaboration process. The second experimental condition ($n = 24$) received the tools halfway (T2) and at the end (T3). The control condition ($n = 27$) did not received tools during collaboration but only completed them at the end (T3).

Measures

Cognitive performance. The grade given to the groups' collaborative writing task (i.e., the essay) was used as a measure of cognitive performance. The essays were graded by two researchers, both experienced in grading essays. The inter-rater reliability was high (Cronbach's $\alpha = .86$).

Social performance. To measure social performance, previously validated instruments (Strijbos, Martens, Jochems, & Broers, 2007) were translated into Dutch and transformed into 5-point Likert scales (1 = totally disagree, 5 = totally agree). The Team Development scale ($k = 13$, $\alpha = .88$) provides information on the perceived level of group cohesion. The Group-process Satisfaction scale ($k = 9$, $\alpha = .79$) provides information on the perceived satisfaction with general group functioning. The Intra-group Conflicts scale ($k = 10$, $\alpha = .88$) provides information on the perceived level of conflict between group members. The Attitude towards Collaborative Problem Solving scale ($k = 9$, $\alpha = .78$) provides information on the perceived level of group effectiveness and how group members felt about working and solving problems in a group.

Task and procedure

The students collaborated in dyads and groups of three or four on a collaborative writing task in sociology. Every student worked at a computer. Each group had to write an essay on a highly relevant current-events topic. Prior to this collaborative writing task, students collaborated for one month choosing the topic, searching for relevant sources, writing a short paper and giving a class presentation. Therefore, the sources required to write the essay were available for all groups. The collaborative writing task consisted of three 45-minute sessions over a period of one week. The groups collaborated in a CSCL environment called Virtual Collaborative Research Institute (VCRI; Jaspers, Broeken, & Erkens, 2002), which is a groupware program designed to support collaborative learning on research projects and inquiry tasks. VCRI will be further described in the Instruments section. Students were instructed to use VCRI to communicate with the other group members and to make complete use of the tools for peer feedback and reflection when the experimental condition allowed this. Students received content information and definitions regarding the six traits on which they had to assess themselves and their peers. Students were told that they had three lessons to complete the task, that it would be graded by their teacher, and that it would affect their grade for the course. The introduction to the task stressed the importance of working together as a group and pointed out that each individual group member was responsible for the successful completion of the group task. To successfully complete the task, all group members had to participate.

While groups used the tools, groups without tools continued working on their collaborative writing task. Time-on-task (writing the essay) was equal for all conditions. At the end of the final session (T3), the peer feedback tool and reflection tool became available for all conditions so that all participants could assess their peers and reflect on their behaviors. Finally, all participants completed a 30-item questionnaire measuring the social performance of the group.

Instruments

Virtual Collaborative Research Institute (VCRI)

The Virtual Collaborative Research Institute (VCRI) is a groupware program that supports collaborative working and learning on research projects and inquiry tasks (Jaspers, Broeken, & Erkens, 2004). VCRI contains more than 10 different tools, but only 5 were used for this experiment (see Figure 1). The Co-Writer (top left) is a shared word-processor for writing a group text. Using the Co-Writer, students can simultaneously work on different parts of their texts. The Chat tool (top center) is used for synchronous communication between group members. The chat history is automatically stored and can be re-read by participants at any time. Notes (bottom right) is a note pad which allows the user to make notes and to copy and paste selected information. Radar for peer feedback (bottom left) and Reflector for reflection (top right) will be described in the following sections. Windows of the available tools are automatically arranged on the screen, when students log on to the VCRI.

Peer assessment tool (Radar)

VCRI was augmented with a peer feedback tool for stimulating and facilitating information of group members' social and cognitive behavior. This information is visualized in a radar diagram; therefore the peer feedback tool

is named 'Radar' (see Figure 2). Radar provides users with anonymous information on how their cognitive and social behavior is perceived by themselves, their peers, and the group as a whole. The information gathered is based on specific traits that have been found to tacitly affect how one 'rates' other people (Brok, Brekelmans, & Wubbels, 2006). Radar provides information on six traits that are important for assessing behavior in groups. Four are related to social or interpersonal behavior, namely (1) influence; (2) friendliness; (3) cooperation; (4) reliability; and two are related to cognitive behavior, namely (5) productivity and (6) quality of contribution. These traits are derived from studies on interpersonal perceptions, interaction, group functioning, and group effectiveness (e.g., Bales, 1988; Brok, Brekelmans, & Wubbels; Kenny, 1994). These traits, as well as the reasons for their choice, are discussed in Phielix, Prins, and Kirschner (in press).
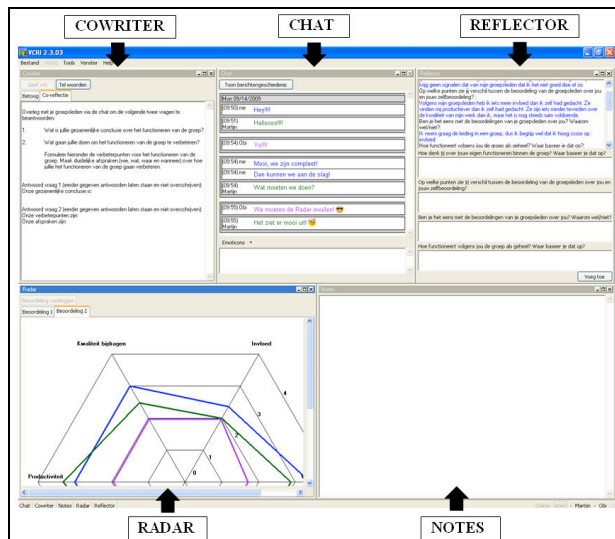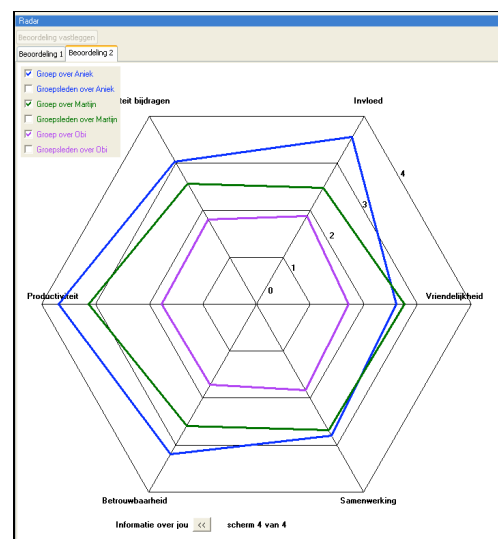

Figure 1. Screenshot of VCRI

Figure 2. Output group assessment

In Radar, group members are both assessors and assessees. As assessor, to-be-assessed peers in the group can be selected and her/his profile will appear as dotted lines in the center circle of the radar diagram. Each group member is represented by a specific color. The assessor rates her/himself and all of the other group members on each of the six traits using a continuous scale ranging from 0 to 4 (0 = none - 4 = very high). Every range, (e.g., from 0 to 1) contains 10 points, so every scale contained 40 points of assessment. To make sure that all assessors interpret the six traits in the same way, assessors saw a text balloon with content information and definitions when they moved the cursor across one of the traits in the tool. For example, when the assessor moves the cursor across 'influence' a balloon pops up with the text 'A high score on influence means that this person has a big influence on what happens in the group, other group members behavior, and the form and content of the group product (the essay)'.

For groups of 3 and 4 members, the assessment is anonymous. Group members can see the assessments of the other group members, but not who entered the data. To stimulate students to complete Radar, they can only gain access to the individual and average assessments of their peers after they have completed the assessment themselves. When all group members have completed their self assessments and peer assessments, two modified radar diagrams become available. The first - Information about yourself - shows the output of the self assessment (e.g., Chris about Chris) along with the average scores of the peer assessments of her/him (e.g., Group about Chris). The self assessment is not taken into account for computing the average scores. To provide more information about the variance in the average score of their peer assessment, students can also choose to view the individual peer assessments about their own behavior (e.g., Group members about Chris). The second - Information about the group (see Figure 2) - represents the average scores of the group members, so that group members can get a general impression about the functioning of the group.

All group members are represented as a solid line in the diagram, each with a different color. The student can include or exclude group members from the diagram by clicking a name in the legend.

Reflection tool (Reflector)

VCRI was also augmented with a reflection tool (Reflector) containing five reflective questions designed to stimulate reflection on different aspects of the group processes taking place. The questions were:

1. What is your opinion on how you functioned in the group? Give arguments to support this.
2. What differences do you see between the assessment received from your peers and your self assessment?

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3. Why do you or do you not agree with your peers concerning your assessment?
4. What is your opinion on how the group is functioning? Give arguments to support this.
5. What does the group think about its functioning in general? Discuss and formulate a conclusion that is shared by all the group members.
6. Set specific goals (who, what, and when) in order to improve group performance.

The first four questions are completed in the Reflector, with completion indicated by clicking an 'Add'-button. This allows the student to share her/his answers with the rest of the group and allows her/him to see the answers of the others. Students can only gain access to the answers of their peers after they have added their own answers so as not to be influenced by one another. The fifth and sixth questions are completed in Co-Writer, in a specific section named Co-Reflection, which allows writing a 'shared' conclusion and formulating goals. The responses made by the students in the Reflector are not scored or evaluated.

Data Analyses

To examine whether Radar and Reflector lead to higher social performance, a one way between-groups ANOVA (two-tailed) with planned comparisons is conducted with the dependent variables 'team development', 'group satisfaction', 'level of group conflicts', and 'attitude towards collaborative problem solving', as measured by the questionnaire at the end of the experiment.

To examine whether Radar and Reflector lead to higher cognitive performance, a one way between-groups ANOVA (two-tailed) with planned comparisons is conducted with the grade on the essay as dependent variable.

Results

Impact of tools on social performance. A one way between-groups ANOVA (two-tailed) with planned comparisons was conducted to compare scores on 'team development', 'group satisfaction', 'level of group conflicts', and 'attitude towards collaborative problem solving', across each of the three conditions. Groups in Condition 1 used the tools from the beginning (T1) of collaboration process until the end (T3); Groups in Condition 2 received and used the tools halfway (T2) and at the end (T3); and Groups in Condition 3 did not use the tools during collaboration, but only completed them at the end (T3). Except where noted, tests were two-sided. The rule of thumb (Cohen, 1988) for effects sizes (η^2) was small $\geq$ .01, medium $\geq$ .06, and large $\geq$ .14. Table 1 shows means and standard deviations for social performance scales per condition.

Table 1. Means and Standard Deviations for Social Performance Scales per Condition

	Condition	N	M	SD
Team development	1 – tools available at T1, T2 and T3	63	4.06	.57
	2 – tools available at T2 and T3	24	3.47	.61
	3 – tools available at T3	25	3.80	.37
Group satisfaction	1 – tools available at T1, T2 and T3	62	3.98	.56
	2 – tools available at T2 and T3	24	3.56	.64
	3 – tools available at T3	25	3.71	.59
Intra-group conflict	1 – tools available at T1, T2 and T3	62	1.95	.59
	2 – tools available at T2 and T3	24	2.41	.66
	3 – tools available at T3	25	2.23	.50
Attitude towards collaborative problem solving	1 – tools available at T1, T2 and T3	62	3.79	.59
	2 – tools available at T2 and T3	24	3.56	.61
	3 – tools available at T3	25	3.65	.55

As expected, groups that used the tools during the complete collaboration process (Condition 1), perceived their team as being better developed, $F (1, 68) = 6.10$, $p = .02$, partial $\eta^2 = .16$, experienced higher levels of group satisfaction, $F (1, 108) = 3.83$, $p = .05$, partial $\eta^2 = .09$, and experienced lower levels of conflicts, $F (1, 108) = 4.07$, $p = .05$, partial $\eta^2 = .10$, than students not using the tools (Condition 3).

Compared to groups that received the tools halfway (Condition 2), groups in Condition 1 perceived their team as being better developed, $F (1, 68) = 17.02$, $p = .00$, partial $\eta^2 = .16$, experienced higher levels of group satisfaction, $F (1, 108) = 9.02$, $p = .00$, partial $\eta^2 = .09$, experienced lower levels of conflicts, $F (1, 108) = 10.68$, $p = .00$, partial $\eta^2 = .10$, and had a more positive attitude towards collaborative problem solving, $F (1, 108) = 2.77$, $p = .05$, partial $\eta^2 = .03$ (one-tailed).

Compared to groups in Condition 3, groups in Condition 2 perceived their team as being less developed, $F (1, 38) = 5.40$, $p = .03$, partial $\eta^2 = .16$, compared to students not using the tools (condition 3).

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Table 2. Means and Standard Deviations for Cognitive Performance per Condition

Condition	N	Cognitive performance (grade essay)			
		M	SD	Min	Max
1 – tools available at T1, T2 and T3	69	6.81	.71	4.0	8.5
2 – tools available at T2 and T3	21	6.54	1.04	4.5	8.5
3 – tools available at T3	27	6.36	1.61	4.0	8.5

Impact of tools on cognitive performance. Table 2 shows means and standard deviations for performance per condition as measured by the essay grades. No significant effects of Radar and Reflector were found.

Discussion and Conclusion

The first aim of this study was to examine whether the use of a peer feedback tool (Radar) and reflection tool (Reflector) would lead to higher social performance, measured by: team development, group satisfaction, level of group conflict, attitude towards collaborative problem solving. As expected, groups using the tools perceived their team as being better developed, experienced higher levels of group satisfaction and lower levels of conflicts, than groups not using the tools or groups using the tools since halfway the collaboration process. Groups using the tools also experienced a more positive attitude towards collaborative problem solving, than groups receiving the tools halfway. Surprisingly, groups receiving the tools halfway perceived their team as being less developed compared to groups not using the tools. An explanation could be that Radar and Reflector made group members aware of their unrealistic positive perception on team development.

The second aim was to examine whether the use of Radar and Reflector would lead to higher cognitive performance, measured by the grade given to the essays. No significant effects of Radar and Reflector were found for grade given to the essays. The lack of a significant effect is probably due to the short period of time in which the groups had to collaborate in order to accomplish the task. Therefore, further studies will examine the effects of Radar and Reflector during a longer period of time (i.e., three months).

In conclusion, the effects of Radar and Reflector are very promising. They show that social group performance in CSCL environments, such as team development, group satisfaction, and level of group conflicts, can be enhanced by adding this easy to complete and easy to interpret peer feedback tool and reflection tool.

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