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Collaborative learning: the effects of trust and open and closed dynamics on consensus and efficacy

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Abstract The current study compared the effects of open versus closed group dynamics on perceived consensus, objective consensus, and perceived efficacy of collaborative learning in participants high and low in dispositional trust in the context of an Interactive Management (IM) session. Interactive management is a computer-mediated collaborative tool designed to enhance group problem-solving by facilitating cooperative inquiry and consensus. In the current study, two groups of 15 undergraduate psychology students ($N = 30$) came together to structure the interdependencies between positive and negative aspects of social media. After screening for trust scores, participants high and low on dispositional trust were randomly assigned to either an open or closed voting condition. The closed voting group were not permitted to discuss the problem relations, but consensus votes were recorded by the group design facilitator. The open group were allowed to discuss the relations before voting. Results indicated that those in the open-voting group, and those in the high dispositional trust group, scored significantly higher on perceived consensus and perceived efficacy of the tool itself. Results are discussed in light of theory and research on collaborative learning.

Keywords Collaboration · Technology · Dialogue · Trust · Consensus · Computer supported collaborative learning

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1 Introduction

Cooperative learning and collaborative inquiry are increasingly influential areas of theory, research, and practice in education (Johnson et al. 2001; Janssen et al. 2010). According to Johnson et al. (2001), cooperative learning refers to the learning which occurs when a group works together to accomplish shared learning goals. Many collaborative inquiry methodologies also emphasise the cognitive and social growth of individuals working together in a group setting (Fawcett and Garton 2005; O'Donnell and O'Kelly 1994). Cooperative learning and collaborative inquiry have been used in various fields including education (Johnson et al. 2001), business (Alavi et al. 1995) and conflict resolution (Broome 2004) using both face-to-face and computer-mediated methods. Computer-mediated methods have received much attention in the research literature recently as they are arguably a logical step forward in our technological and efficiency-driven society.

While there is a large research literature to suggest that cooperative learning and collaborative inquiry can be efficacious strategies that facilitate student learning, Janssen et al. (2010) noted that the majority of the research in the area has been effect-oriented in nature, that is, examining the effects of cooperation and collaboration on dependant variables such as student achievement, time on task and use of metacognitive strategies (Nichols 1996; Klein and Pridemore 1992; Mevarech and Kramarski 2003). Janssen et al. suggested that more process-oriented research in the area is warranted. Process-oriented research focuses on the process of collaboration as opposed to the effect of the collaboration process. To date there has been little research investigating social psychological variables which may impact on the collaborative learning process. The current study will investigate such variables in the context of Computer-Supported Collaborative Learning (CSCL).

Computer-supported collaborative learning is a sub-area within the learning sciences concerned with how learning can be aided by the use of computers. There are arguments for and against the use of computer technology in the classroom. Those who are critical of the use of computers in education see them as mundane and anti-social, and view such learning as a mechanical and inhumane method of training. Proponents of CSCL, on the other hand, suggest that the integration of computer software and education can bring students together and can provide both creative activities of intellectual development and social interaction that facilitate learning (Stahl et al. 2006).

Importantly, when one is considering CSCL, it must be noted that there are significant variations between different CSCL tools. One of the main differences revolves around the levels of interaction and dialogue which are inherent in the methodology or process. CSCL tools can be based on email, discussion forums, instant messaging, videoconferencing etc. (Stahl et al. 2006); these varying level of dialogue have been shown to have an effect on the outcomes of CSCL exercises. For example, Ada (2009) examined how interactivity in a CSCL environment contributed to the fostering of higher-order thinking skills. Six groups with four-to-five participants in each group engaged in a 7-week project examining developments in textile fibres and fabrics. The degree of intra-group interactivity was measured using the number of direct responses and commentaries to messages in a discussion forum. It was found that the level of

interactivity using the discussion forum significantly influenced the quality of learning outcomes.

However, while there is accumulating evidence suggesting that dialogue and interaction can facilitate better learning outcomes, there has been much less research conducted on the effects of dialogue on other critical psychosocial outcomes that may be relevant to the efficacy of CSCL exercises when applied in an educational context. For example, it is likely that interaction and dialogue are critical to positive psychosocial outcomes in group learning contexts, including trust, consensus and perceived efficacy of the group learning process. Indirect support for this position is provided by studies showing that trust is more difficult to create in virtual teams due to the lack of local, face-to-face communication (Rocco 1998).

Flowers (1977) found that open group dynamics where dialogue and discussion are encouraged facilitates not only more solutions in group problem solving work, but also more sharing of information in comparison with groups where dialogue and discussion are not encouraged. Similarly, research suggests that higher levels of shared trust in a group lead to increased levels of knowledge sharing (Roberts and O'Reilly 1974), with individual group members perceiving this knowledge sharing as less costly (Currall and Judge 1995). Furthermore, higher levels of shared trust in a group may increase the likelihood that knowledge received is adequately understood and absorbed so that the individual can put it to use (Mayer et al. 1995). This research suggests that both dialogue and trust may influence other important outcomes in collaborative learning environments, including perceived and objective consensus and perceived efficacy of the methodologies and tools that support learning.

1.1 Interactive management

One such computer-mediated collaborative tool is Interactive Management (IM). Interactive management is an idea structuring methodology designed to facilitate group problem solving (Warfield and Cardenas 1994). Interactive management is designed to facilitate cooperative inquiry and consensus in relation to a problem. The IM process begins when a group of people with an interest in resolving a problematic situation come together in a designated room and are asked to compile a set of raw ideas which they feel might potentially have an influence on the problem in question. Voting helps the group to identify the factors or issues they agree have the most critical impact on the problem. Next, using IM software, each of the critical issues are compared systematically in pairs by asking the question: "Does issue A significantly influence issue B?" Unless there is a clear majority consensus that A impacts on B, the relation does not appear in the final analysis. This process continues until all of the critical issues have been compared. The IM software then generates a problematique, which is a graphical representation of the problem-structure, showing how all the critical problem factors or issues are interrelated. This consensus-based problematique becomes the catalyst for discussion and planning of solutions and collective action in response to the problem situation. The fact that the problematique provides a logically structured representation of the problem facilitates, in principle, the formulation of logical solutions for the resolution of the problem. When group members are satisfied that

they have adequately modelled both the problem and a logical action plan for resolution of the problem, the IM session closes. Each member then leaves with a coherent and well defined plan for resolution of the problem and a clear representation of how the various plans and actions of each member will come together to solve the problem (Warfield 2006).

Notably, psychosocial variables such as trust, consensus, and perceived efficacy of learning tools may be important to consider in any effort to integrate CSCL tools such as IM into the modern web environment. While IM has been applied in many different situations (Warfield 2006) the software has not yet been used in a social domain in which it has profound potential, as a web-integrated collaborative tool. The potential for combining quality collaborative inquiry with online networking is an exciting prospect. However, if IM is to become a web-integrated tool, certain issues must be considered, one of which is a common issue with all online CSCL, the lack of face-to-face, personal and local communication among the team members, and the impact this can have on the outcomes of the CSCL process. Other issues that need to be considered are individual difference variables that may negatively or positively impact CSCL outcomes. Again, participants who are low on dispositional trust may respond less favourably to CSCL opportunities as trust has been shown to be one of the fundamental factors in determining the success and failure of virtual teams (Kanawattanachai and Yoo 2002). This negative impact of low dispositional trust may be exacerbated in situations where dialogue is restricted. Conversely, open dialogue may serve to increase levels of group trust in a collaborative learning setting (Bohm 1996), and this increase in trust levels may lead to more open communication (Holden 1990; Smith and Barclay 1997), and increased cooperation (Parks et al. 1996).

Similarly, both perceived and objective consensus are potentially important variables that need to be considered in efforts to enhance the successful workings of groups using CSCL tools, particularly if the goal is to use CSCL tools to enhance group problem solving and decision making. The term consensus is often used to refer to the extent to which two or more people agree in their ratings of a target (Kenny et al. 1994). Reaching consensus on a solution to a problem is advantageous for many reasons, especially with regard to implementing an action plan designed to resolve a problematic situation. If there is a high level of consensus in the group about the decision reached and the way forward, progress toward a solution to a shared problem is likely to be much easier to achieve. For example, Mohammed and Ringseis (2001) found that groups who reach higher levels of consensus in relation to a problem had greater expectations about the implementation of decisions reached by the group, and also experienced higher levels of overall satisfaction. Mohammed and Ringseis also found that the highest levels of consensus were evident in groups in which the members questioned each other's suggestions, accepted legitimate suggestions and incorporated other's viewpoints into their own perspective. What is not clear from such results is if this relationship exists for both perceived and objective consensus, as the majority of studies have focused on objective consensus. Higher levels of perceived consensus may serve to complement high levels of objective consensus when it comes to the

sustained successful workings of a group who seek to resolve a problematic situation.

Interestingly, while IM is designed to facilitate the construction of a consensus model (or problematique), no research has examined the impact of the IM process itself on either perceived consensus or on changes in levels of objective consensus (i.e. levels of agreement on the relative significance of key influences in a problematique). In terms of objective consensus, a problematique may include many discrete influences that are deemed important by the group but there may be variation across the group in ratings of the relative significance of discrete paths of influence in the problematique. The IM process may alter levels of objective consensus; however, this may be more likely in the context of open discussion, because members of a working group who initially have disparate views in relation to the nature of a problem may find greater grounds for consensus after being provided with the opportunity to openly discuss their thinking. This might be particularly the case in those who are higher in dispositional trust as people who are high in dispositional trust have been found to engage in more open communication, social negotiation, critical thinking and social interaction (Kreijns et al. 2002).

To examine some of these issues further, the current study compared the effects of open versus closed voting on perceived consensus, objective consensus, and perceived efficacy of collaborative learning in participants high and low in dispositional trust in the context of an IM structuring session. Participants high and low in dispositional trust were assigned to one of two experimental Interpetive Structural Modelling (ISM) sessions. IM utilizes several group methodologies, one of which is ISM. Interpetive structural modelling is a process used to guide a group through questions intended to define the scope of a problem, and the relationship of its dependent parts. The session in the current study focused on the problem of the costs and benefits of online social media. Two groups worked on the problem: a closed voting group where interpersonal visual cues were restricted and verbal interaction was not permitted, and an open voting group where open dialogue and discussion in relation to each of the ISM relations was permitted and facilitated and where interpersonal visual cues were available while the group worked to build a consensus ISM model via summative voting.

Notably, while the impact of face-to-face versus virtual collaboration on group trust has been examined (e.g., Rocco 1998), the impact of interaction or dialogue on trust in, or perceived efficacy of, the technology itself has not been investigated in CSCL studies to date. Also, no study to date has examined the effect of dispositional trust on the CSCL outcomes of perceived and objective consensus, or whether dispositional trust impacts directly on an individual's trust of CSCL tools. Marsh and Dibben (2005) argue that it is vital that we understand and can facilitate, group trust and trust in CSCL technology in order to enhance the quality of our workings with information and information technologies. Furthermore, the trust that users have in the technology, according to Marsh and Dibben, will influence the prospective user's decision to adopt it. It is therefore important for research to be conducted to determine which factors influence trust in, or perceived efficacy of, the computer-mediated process itself.

In the current study it was hypothesised that both higher levels of dispositional trust and more open group discussion would predict higher levels of perceived and objective consensus and perceived efficacy of the ISM process. In addition to a main

effect of voting condition and disposition trust on outcomes, an interaction effect was predicted. Specifically, it was predicted that, when compared with participants in the closed voting group, participants in the open voting group would report higher perceived and objective consensus and higher perceived efficacy of the ISM process, and that these effects would be largest for individuals who are high on dispositional trust.

2 Method

2.1 Participants

Participants were first and second year psychology students ($N = 30$) comprising 8 males and 22 females, aged between 17 and 32 years ($M = 19.4$, $SD = 2.90$), from the National University of Ireland, Galway. Participants were recruited prior to the beginning of lectures. They were offered research participation credits in exchange for their participation. Two groups of 15 participants, matched in terms of both mean and variance on the dispositional trust scale, were assigned at random to either the open or closed voting condition. In each group there were 11 female and 4 male participants.

2.2 Materials/measures

2.2.1 Interpretive structural modelling software

Interpretive structural modelling is a computer-mediated idea-structuring methodology that is designed to facilitate group problem solving (Warfield and Cardenas 1994). The ISM programme was run on a PC by facilitators in both the open-voting and closed-voting rooms. The relations that groups were to vote on were displayed on a large screen via an overhead projector (see procedure section below for a more detailed description of the ISM process).

2.2.2 Trust

Dispositional trust was measured using a combination of the scale developed by Pearce et al. (1992) and that of Jarvenpaa et al. (1998). The Pearce scale included 5 items; the Jarvenpa et al. scale included 6 items. The 11 items were rated on a 5-point likert scale (1 = strongly agree, 5 = strongly disagree; e.g., "Most people tell the truth about the limits of their knowledge"). The scale had good internal consistency ($\alpha = .72$).

2.2.3 Perceived efficacy of ISM

Perceived efficacy of the ISM process itself was measured using a scale developed specifically for this study as there was no such scale available. The scale included 7 items rated on a 5-point likert scale (1 = strongly agree, 5 = strongly disagree; e.g. "I believe that IM can be used to solve problems effectively"). The scale had good internal consistency ($\alpha = .88$).

2.2.4 Perceived consensus

The method of measurement used in this study was similar to that used by Kenworthy and Miller (2001): participants first gave their opinion (via the voting of problems relations) and were then asked to rate how representative their opinions were in relation to the opinion of other members of their group. While Kenworthy and Miller asked participants for a percentage estimate, we decided to test their perceived consensus using a 4-item scale with five-point Likert ratings (1 = strongly agree, 5 = strongly disagree; e.g., "Generally speaking, my peers and I approach online social media in a similar manner"). The scale had good internal consistency ($\alpha = .77$).

2.2.5 Objective consensus

Objective consensus was measured using Kendall's coefficient of concordance (Kendall's W) in relation to Likert scale judgement across a random set of ten relations from the full set of propositional interdependencies across the 10 × 10 proposition matrix. A sample item from this set is: "Not wanting personal details to be seen by everyone significantly impacts on the desire to share information and experiences with your network of contacts, family and friends". Items were scored by each individual using a 7-point Likert scale (1 = strongly agree, 7 = strongly disagree). Objective consensus, as measured by Kendall's W, was computed for each group before and after the experimental manipulation (i.e., open versus closed voting). High values occur when there is greater agreement between raters in the group.

2.3 Design

Two 2 (condition: open versus closed) × 2 (dispositional trust: low versus high) between-subjects ANOVAs were carried out to assess the effects of dispositional trust and open versus closed voting on perceived consensus and perceived efficacy in ISM respectively. A 2 (condition: open versus closed) × 2 (pre- versus post- manipulation) mixed ANOVA was also used to assess the effects of open versus closed voting on dispositional trust before and after the experimental manipulation. Finally, a Statistica™ coefficient comparison test was used to assess the statistical significance of differences in objective consensus across groups before and after the experimental manipulation (i.e., differences in Kendall's W).

2.4 Procedure

At the time of recruitment, prospective participants were presented with some information in relation to the nature of the study, including details as to its focus on collaborative inquiry and the costs and benefits of online social media. Informed consent was obtained and a few weeks prior to the laboratory component of the study, participants were presented with a pack which contained the dispositional trust scale and a set of sixteen statements, eight of which related to possible privacy/security issues associated with online social media and eight of which related to possible benefits/uses of

online social media. Participants were asked to, first, rank order the five most important privacy/security issues and, second, rank order the five most important benefits/uses of online social media. Participants then completed the dispositional trust scale. The statement rank-orderings and trust scale data were collected and coded. The sum of ranks across the sample as a whole ($N = 30$) were computed and the top five costs and top five benefits of online social media were identified for use in the ISM session, the purpose of which was to map interdependencies between the costs and benefits of online social media.

Participants were invited to part-take in an ISM session. Participants were divided into high and low dispositional trust by means of a median split based on their dispositional trust scores. Participants high and low on dispositional trust were then randomly allocated to either the open ($n = 15$, $M = 19.60$ years, $SD = 3.54$ years) or closed ($n = 15$, $M = 19.27$ years, $SD = 2.19$ years) voting group. As a result, there were four categories of participants: open-group, high-trust ($n = 8$), open-group, low-trust ($n = 7$), closed-group, high-trust ($n = 7$) and closed-group, low-trust ($n = 8$). Before the ISM session began, each participant completed the objective consensus scale.

Participants assigned to the closed voting group were directed to a room in which the seating was arranged in rows facing the group facilitator, thereby limiting non-verbal communication between participants. The ISM process was explained to participants and then the ISM session began. A set of relational statements appeared one at a time on an over-head screen and participants were informed that they were not permitted to openly discuss the relations with the other group members; they were asked instead to raise their hand to declare their vote when it was called for. Specifically, for each relation presented on the screen (does A influence B), participants were asked to think about the relation and after a period of deliberation (30–40 s), participants were asked to raise their hands if they believed that, yes, A does indeed influence B. If a minimum of 10 out the 15 participants voted 'yes', then a yes vote was entered and the relation appeared in the final problematique.

Participants in the open group were directed to a room in which chairs were arranged in a circle, such that all of the group members could see each other. Again, the ISM process was explained to participants and then the ISM session began. Relational statements were presented one at a time on an over-head screen and participants, under the direction of a neutral facilitator, were asked to openly discuss each relation with the other members of their group before voting. Deliberation and discussion was fostered by the facilitator and it continued until all views in the group had been expressed, after which the facilitator asked participants to raise their hands if they believed that, yes, A does indeed influence B. Again, if a minimum of 10 out the 15 participants voted 'yes', then a yes vote was entered and the relation appeared in the final problematique When all of the relations had been run through in each group, the IM session closed. Participants then completed the set of scales for a second time, that is, both objective and perceived consensus scales, a perceived efficacy of ISM scale and a dispositional trust scale.

Table 1 Means and standard deviations for perceived consensus and perceived efficacy of ISM

Trust level	Condition		Perceived consensus	Perceived efficacy
Low	Open	M	13.14	21.71
		SD	1.95	3.30
	Closed	M	11.00	18.63
		SD	2.14	4.07
High	Open	M	15.75	25.13
		SD	2.43	2.30
	Closed	M	13.29	21.14
		SD	2.63	5.40

3 Results

A series of two 2 (condition: open versus closed) $\times 2$ (dispositional trust: high versus low trust) between subjects ANOVA were used to examine effects on perceived consensus and perceived efficacy of the ISM process. Objective consensus was analyzed using Kendall's coefficient of concordance (Kendall's W).

3.1 Perceived efficacy

The ANOVA revealed a significant main effect of trust level on perceived efficacy of ISM, $F(1, 26) = 4.34$, $p = .047$, partial $\eta^2 = .14$, with higher perceived efficacy in the high trust group ($M = 23.27$, $SD = 4.40$) than in the low trust group ($M = 20.07$, $SD = 3.94$). There was also a significant main effect of condition, $F(1, 26) = 6.18$, $p = .02$, partial $\eta^2 = .19$, with higher perceived efficacy in the open group ($M = 23.53$, $SD = 3.23$) than in the closed group ($M = 19.80$, $SD = 4.74$). There was no trust $\times$ condition interaction effect. The means and standard deviations for perceived efficacy are presented in Table 1.

3.2 Perceived consensus

The ANOVA revealed a significant main effect of trust on perceived consensus, $F(1, 26) = 8.43$, $p = .007$, partial $\eta^2 = .25$, with perceived consensus higher in the high trust group ($M = 14.6$, $SD = 2.75$) than in the low trust group ($M = 12.0$, $SD = 2.27$). There was also a main effect of condition, $F(1, 26) = 7.50$, $p = .011$, partial $\eta^2 = .22$, with perceived consensus higher in the open group ($M = 14.53$, $SD = 2.53$) than in the closed condition ($M = 12.07$, $SD = 2.58$). There was no trust $\times$ condition interaction effect. The means and standard deviations are presented in Table 1.

3.3 Objective consensus

Kendall's coefficient of concordance (Kendall's W) was used to measure concordance (i.e., agreement of ratings in relation to specific ISM paths of influence) within groups

Table 2 Objective consensus (Kendall's W) before and after experimental manipulation

Condition	Trust level	Pre	Post
Open	Low	.17	.26
	High	.44	.18[a]
Closed	Low	.21	.38
	High	.47	.50

Higher Kendall's W scores = Higher consensus
[a] Significant change from pre to post ($p < .05$)

before and after the experimental manipulation. Surprisingly, although levels of objective consensus were relatively high in the high trust group prior to the ISM session (see Table 2), their Kendall's W reduced from .44 to .18 from before to after open discussion and voting, suggesting a reduction in their level of agreement in rating specific ISM paths of influence. However, this change was not statistically significant. Furthermore, although there was a trend for objective consensus to increase in both open and closed voting conditions for participants low in dispositional trust, again, these differences were not statistically significant (Table 2).

4 Discussion

The current study examined the effects of dispositional trust and open versus closed group voting on perceived consensus, objective consensus, and perceived efficacy of collaborative learning in the context of an ISM session. Results indicated that that those with higher dispositional trust levels, and those in more open working groups, reported higher levels of perceived consensus in response to the group design problem and higher perceived efficacy of the ISM process.

In relation to the effect of dispositional trust on perceived efficacy of ISM previous research suggests that trust can influence critical psychosocial processes that may in turn influence the perceived efficacy of collaborative learning activities. For example dispositional trust is associated with a preference for, social negotiation, critical thinking and solution finding (Kreijns et al. 2002). These factors may have mediated the relationship between dispositional trust and perceived efficacy of the ISM process in this study. Conversely, the effect of dispositional trust on perceived efficacy may have been more direct in the current study, with those high on dispositional trust being generally more agreeable and thus rating the efficacy of the ISM process as higher overall.

The results of the current study also revealed that, in comparison with those in the closed group, participants in the open voting group reported higher levels of perceived efficacy in relation to the ISM methodology In addition to the effects of disposition trust, this finding suggests that those in the open voting group found the group design methodology to be broadly useful and valid as a method of mapping the interdependencies between the costs and benefits of social networking. This result is consistent with research conducted by Flowers (1977) who found that more open groups that used

dialogue and discussion when working together establish positive norms of information sharing that may influence their responsiveness to group design methodologies. Conversely, those in the closed condition, deprived of the opportunity for dialogue before their collective voting, may not have considered the process to be an effective method in helping them to structure their collective knowledge and reach a consensus view in relation to the costs and benefits of social networking, which in turn led them to judge the IM methodology as less valid and effective.

Notably, the results of the current study also revealed a significant main effect of both dispositional trust and structured discussion on perceived consensus scores. Participants with higher dispositional trust reported higher levels of perceived consensus in response to the collaborative problem structuring efforts of the group. Group discussion in relation to each ISM vote also led to higher perceived consensus. Although dispositional trust did not interact with the open versus closed voting experimental condition, an analysis of the means across groups indicated that the highest perceived consensus scores were observed in the open-voting, high-trust group, and the lowest perceived consensus scores were observed in the closed-voting, low-trust group. The effect of both dispositional trust and open group dynamics in this regard represents an important finding in relation to CSCL tool use, and IM in particular, as higher perceived consensus is likely to lead to higher endorsement by the group of any action in response to a shared problem. Notably, achieving higher levels of consensus and promoting more coherent collective action was a critical objective of Warfield when he first developed the IM process (Warfield and Cardenas 1994). Furthermore, the results of the current study resonate with the results of a study conducted by Mohammed and Ringseis (2001), who found that more open groups had higher expectations in relation to the successful implementation of any decision reached by the group. Taken together, the impact of both open voting and high dispositional trust on perceived consensus and perceived efficacy of the ISM process highlight the fact that both individual difference variables and contextual variables associated with conditions of tool use may have an important influence on CSCL outcomes.

The results of the current study also revealed a trend toward a decrease in objective consensus in the open, high-trust group. This may suggest that the open, high-trust group, although judging themselves to be higher in levels of perceived consensus, were actually developing a more differentiated and complex view in relation to the influences at play in the problematic situation. This is consistent with the results from Flowers (1977) who found that participants in more open groups produced more solutions to problems and used more of the information available to them. This is also consistent with research which suggests that open, positive, and other-affirming interactions in group interaction contexts facilitates more diversity and creativity in the range of ideas that are expressed (Fredrickson and Losada 2005). Future research should seek to clarify whether or not trust and open dialogue influence the emergence of a complex, differentiated view in the context of group-based system design work, and what impact if any this has on the ability of a group to act in a cohesive manner to resolve problematic situations. However, it would also be important that future studies seek to examine these effects using a larger sample size than was used in the current study. The non-parametric comparison of Kendall's coefficient of concordance using

small samples in the current study was not ideal, and future studies should seek to replicate the current research using larger samples.

The results of the current study, combined with results from studies showing increased learning gains in more open and interactive groups (e.g. Ada 2009) suggest that open discussion and dialogue are critical factors in the success of CSCL tool use. These results also have implications for the future design of CSCL tools and how they are used. For example, Peterson (1997) highlighted the effect that a group leader's directiveness can have on the outcomes of collaborative working sessions. Peterson found that process-directive leaders, who aimed to foster the decision-making process by encouraging discussion and by remaining open regarding their own position, facilitated more positive group processes and outcomes than outcome-directive leaders who did not encourage discussion in the group and who focused solely on reaching a decision. As such, in the context of CSCL use, it may be imperative that the facilitator of any group session provide ample opportunities for open dialogue and discussion in the group.

The results of the current study may also have implications for the potential use of CSCL tools such as IM in an online context. As was shown in this study, both the perceived efficacy of ISM and perceived consensus of the decision reached were higher in open when compared with closed groups. Therefore, if IM software is to be redesigned for use in an interactive Web environment it must be designed in such a way as to facilitate open group dialogue and discussion. Considering the exponential growth of research in computer-mediated collaboration (Rocco 1998), it is surprising that so little research has addressed the perceived efficacy of collaborative software tools and the impact of CSCL tool use in different experimental conditions on perceived and objective consensus in working groups. It is important for the future of CSCL tool use that the tools are perceived as efficacious by those wishing to avail of them. The results of the present study suggest that when designing or implementing CSCL tools such as IM in an online environment, every effort should be made to ensure that the group interaction is as open as possible. Integrating the facility for open dialogue and discussion in online collaborative environments may be a challenge, but it is likely that these features of online collaborative inquiry and problem solving will be important for the future of the web.

4.1 Limitations and future research needs

Although this study highlights the importance of both dispositional trust and open dialogue in collaborative learning settings, there are a number of limitations to the current study that need to be addressed in future research. First, although the purpose of the experimental manipulation was to examine variation in outcomes associated with open versus closed group voting, there was also systematic variation in the length of time for which the two groups deliberated before voting. Based on our pilot study, it was not deemed satisfactory to leave people in the closed-voting group for too long before voting, as this created an uncomfortable atmosphere in the group. Therefore, the facilitator usually called for a vote after approximately 30–40 s. In the open voting group, deliberations had to continue until all the views in the room were expressed and with

15 people in the group, this could take up to 10 min for any given relation. However, the strategy used by the facilitator in the open voting group was to allow for longer periods of deliberation for the first 15 relations and then begin to request votes after less time thereafter. Decisions also came faster (sometimes within 10 s) over time in the open voting group as they became more familiar with the propositions and relations in the set and thus began to formulate more refined views in relation to influences at play.

Nevertheless, this confound of voting condition with deliberation time was a somewhat unavoidable consequence of the experimental manipulation used in the current study. Ultimately, the open voting ISM session lasted 110 min whereas the closed voting session lasted 45 min. While this is to be expected due to the fact that the open condition lends itself to greater engagement with the problem-topic, it may nonetheless represent a study limitation as the increased time individuals spent interacting with one another in the open group setting may have influenced their perceived consensus and trust and their perceived efficacy of the ISM process. This limitation may be addressed in future research by providing those in the closed group with reading material pertaining to the problem at hand between each vote, thereby removing the variable of time spent engaged in the process.

Second, another potential limitation of the current study is the fact that the measures used in this experiment for trust, perceived consensus, perceived efficacy of ISM and objective consensus were self-report measures. Self-report measures are susceptible to issues of response bias and it is possible for participants to answer in ways which do not reflect their true beliefs. Future research might seek to examine the effects of dispositional trust and open group dynamics on subsequent collaborative actions in response to ISM problem structuring. It may be that higher levels of perceived consensus and perceived efficacy of ISM are critical predictors of subsequent collaborative behaviour focused on implementing solutions to problems where a high level of consensus has been established.

Third, in the current study individuals with high and low dispositional trust were mixed in the open and closed voting groups. This may have influenced the nature of interaction in the open voting condition in unique ways and it would be useful for future research to examine separately and more closely the style of interaction of participants high versus low in dispositional trust, in addition to groups that include a mix of participants both high and low in dispositional trust. Also, future studies in the area should seek to record and analyse conversational dynamics in these different open discussion working groups, for example, to explore factors that influence the emergence of higher levels of group consensus and the possible transformation from lower to higher levels of group trust in IM sessions.

One final limitation relates to the sample used in this study. The sample size itself was small and consisted of only 2 groups. While it is necessary to employ small groups in studies of collaborative learning, it may be beneficial for future studies to compare the effects across a larger number of groups. Also, the sample consisted of 22 females and 8 males. While there were an equal number of males and females in both experimental conditions, due to the small sample size it was not possible to examine the effects of the experimental manipulation on males and females separately. In light of these limitations, the results of the current study should be interpreted with caution and

future research is needed to examine these effects using multiple groups and a larger sample size. Also, it might be useful in future studies to examine the effects of open versus closed group dynamics on males and females separately, particularly given that research suggests that males and females may respond differently to collaborative enquiry demands, especially in the context of computer-supported collaborative enquiry (Prinsen et al. 2007).

5 Summary and conclusion

Cooperative learning is one of the most prevalent and influential areas of theory, research, and practice in education (Johnson et al. 2001). While it has long been shown that collaborative learning has significant positive effects on learning and productivity, the social and psychological factors which impact on this process have not been the focus of very intensive investigation. Effect-oriented research to date has shown the positive effects of collaborative learning on dependant variables such as student achievement, time on task and use of metacognitive strategies (Nichols 1996; Klein and Pridemore 1992; Mevarech and Kramarski 2003). This study adopted a process-oriented approach by simulating both open versus closed group dynamics in an ISM session. It was shown that open dialogue and discussion in the group led to significantly higher perceived consensus and perceived efficacy of ISM in comparison with a condition where dialogue and discussion were restricted. Participants with higher levels of dispositional trust also reported significantly higher perceived consensus and perceived efficacy of ISM. These results have implications for the design and implementation of CSCL exercises and tools in the classroom environment, and they further suggest that great care should be taken to facilitate trust and the open exchange of ideas when CSCL tools are embedded in a web learning environment.

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