Group and Individual Level Effects of Supporting Socio-Cognitive Conflict Awareness and Its Resolution in Large SNS Discussion Groups: A Social Network Analysis

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Abstract: SNS (social networking sites) provide great opportunities for access to knowledge sources and equity in publicly expressing ideas, opinions and attitudes. They define a rich context of socio-cognitive interactions in which conflict can arise. Supports for conflict awareness and argumentation processes to resolve the conflict can foster learning. This article presents a comparative 2×2 field study (N=98) of such supports in a university course that included weekly SNS discussions. Group Awareness Tools (GATs) were used to increase attitude conflict awareness, and argumentation scripts as a cognitive guidance to help learners capitalize on this awareness and resolve the conflict productively. We use Social Network Analysis (SNA) to gain a group-level understanding of the effects of argumentation on attitude change relative to peer interactions. We measure number of interactions, information flow control, influence distribution, and attitude similarity. Both GATs and argumentation script influence group processes, but argumentation script shows more substantial influence.

Keywords: computer-supported collaborative learning, social network analysis, group awareness tools, argumentation script, social networking sites

Attitude change through argumentation in SNS using group awareness tools and argumentation scripts

Socio-cognitive conflict and attitude change in SNS

SNS provide a great possibility for equity and access to sources of knowledge, but also for public expression of ideas, opinions and attitudes that can lead to pluralistic exchange. They define a rich context of socio-cognitive interactions in which conflict can arise, but they do not necessarily promote productive interactions. In particular, discussions in public settings foster the externalization of attitudes and afford chances for learners to scrutinize their own attitudes and those of their peers (Nussbaum, 2008), thus facilitating interaction and elaboration that could lead to socio-cognitive conflict and attitude change. However, research has shown that while on the one hand social media can instigate socio-cognitive conflict beyond the grasp of existing purpose-specific collaborative learning tools by leveraging differences in attitude, on the other hand the public nature of the discussions may rather reinforce private beliefs and attitudes and prohibit change (Lampert, Rittenhouse, & Crumbaugh, 1996). Peers play an important part in shaping new opinions and perspectives during group discussions in public settings. They, thus, influence group decisions by encouraging networked communication and collective decision-making (Chaiken, Wood, & Eagly, 1996; Cialdini & Trost, 1998; Wood 2000). More research is needed to better understand the socio-cognitive processes involved in SNS peer interactions in their own right, but also to identify supports that can enhance interactions and help learners to productively resolve conflicts in SNS and leverage attitude differences and socio-cognitive conflict for attitude change.

Argumentative knowledge construction to promote communication attitude change

Attitudes influence our ability to learn and acquire new skills, and may often hinder learning (Erber, Hodges, & Wilson, 1995). Although, communication theory seminars are becoming increasingly common in teacher trainee university courses to modify teachers' attitudes and improve their communication skills, negative attitudes towards the need for good communication skills are pronounced among teacher trainees (Ihmeideh & Al-omari, 2010). However, communication is a key skill for teachers and higher education professionals due to their everyday involvement with students, parents, colleagues and school administrative staff, requiring skillful intervention through communication. Additionally, individual attitudes are stable and long-term deep learning and conflict awareness are prerequisites for attitude change (Erber et al, 1995). *Argumentative Knowledge Construction* (AKC), which is the deliberate practice of elaborating learning material by constructing formally and semantically sound arguments (Weinberger & Fischer, 2006) can aid such deep learning. Argumentation

can not only induce increased self-reflection and conflict awareness, but can also help in attitude co-construction (Andriessen, 2006; Asterhan & Schwarz, 2009; Baker, 2003; Felton & Kuhn, 2001, Sassenberg & Boos, 2003, Tsovaltzi, Puhl, Judele, & Weinberger, 2014; Wenger, McDermott, & Snyder, 2002)).

Computer-Supported Collaborative Learning supports for attitude change in SNS

Computer-Supported Collaborative Learning (CSCL) environments have been systematically enhanced and utilized to induce attitude change and promote knowledge acquisition (Buder & Bodemer, 2008; Dillenbourg & Fischer, 2007; Puhl, Tsovaltzi, & Weinberger, 2015a; 2015b). SNS, like Facebook, provide a modifiable platform through apps that can host argumentative CSCL learning scenarios in which learners can exchange and formulate their elaborate opinions and arguments during meaningful discussions (Greenhow, 2008; Greenhow, Menzer, & Gibbins, 2012; Puhl et al; 2015a; 2015b). Prominent CSLC supports like GAT and argumentation scripts can, thus, be augmented to implement AKC in SNS and make use of group level interactions for learning and attitude change. *GATs* provide learners with information regarding actual group processes. They can, for instance, visualize group process information (Buder & Bodemer, 2008; Gutwin & Greenberg, 2002) to highlight conflicting opinions in discussions and foster learning and collaboration through socio-emotional and motivational processes. The increased awareness of ones' opinion and attitude afforded by GATs, especially in comparison to others in a group, can help in making differences salient, a prerequisite of dissonance and attitude change (Festinger, 1957). Similarly, in SNS, GATs could foster socio-cognitive conflict and prompt more individuals to actively engage in meaningful dialogue regarding conflicts, especially when quantitative representations are combined with qualitative ones (Erkens, Schlottbom & Bodemer, 2016). GATs can, thus, assist in forming new communication channels between learners and increase the number of interactions in an attempt to understand and resolve conflicts. Additionally, increasing the number of learners central to discussions, GATs could also enhance individual control on information flow and the subsequent distribution of influence in the network promoting increased idea exchange and knowledge co-construction. In effect, GATs can support constructive discussions and conflict resolution, through which learners may form similar attitudes. *Scripts* are socio-cognitive structures that can provide specific guidance and scaffold group discussions during collaborative learning scenarios (Fischer, Kollar, Stegmann & Wecker, 2013). *Argumentation scripts* aim to improve argumentation quality. They may prompt learners to elaborate their arguments and clarify their opinions, and thus foster AKC (Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2012). They may guide learners to analyze the lines of argumentation provided by both their peer group and themselves during discussions, scrutinize their attitudes, and critically reflect on them. Argumentation scripts may also help participants in providing rational epistemic counter-arguments, leading to mutual conflict resolution (Kollar, Fischer & Slotta, 2007) which forges similar knowledge (knowledge convergence; Weinberger, Stegmann, & Fischer, 2007). Argumentation scripts in SNS might also forge similar attitudes overtime. In previous studies, inferential statistics has indicated that over more time (semester long), SNS discussions with incorporated GATs and argumentation scripts, and their combination influence learners' attitude towards communication skills by introducing socio-cognitive conflict and improving argumentation quality (Puhl et al, 2015a).

The present work aims to inculcate learners' mutual attitude change and knowledge gain during argumentative SNS discussions in distinctively designed and implemented Facebook apps. The apps provide GATs support to foster socio-cognitive conflict and promote interactivity towards its resolution. They also implement argumentation scripts which intent to improve argumentation quality and resolve conflict productively. We aim to capture and understand group dynamics in SNS discussions as part of a teacher communication seminar. We define group dynamics as the unforeseeable patterns of communication flow among learners, and the *flow* of resources: knowledge in the form of ideas and opinions of the peers that may lead to attitude change through discussions. We also want to observe how GATs vs. argumentation scripts influence group dynamics in SNS, and whether they provide opportunities or form constraints for interactivity, learning and attitude change. We combine SNA and inferential statistics (Halatchliyski, 2011) to test the effect of these supports on group dynamics. We test if GATs and argumentation scripts enhance network measures, support learners and facilitate discussions in SNS. We aim at enhancing our understanding on how CSCL supports may be used to leverage social influence and promote attitude change and learning in SNS.

Method

We conducted a 2x2 semester long field study (see Table 1) with German teacher trainees (N=98) in two rounds (two consecutive semesters). The data for script conditions were collected in the second round. Facebook, a prominent SNS, was used to integrate online argumentative discussions with face-to-face teacher training university seminars on communication theory over 9 weeks. The participants filled out a case-based questionnaire weekly based on every-day social interaction scenarios in the school, to capture their

communication attitudes. Each question comprised of two communication attitude dimensions: multi-perspective / flexible attitudes vs. goal-oriented / structured attitudes, following Buder & Bodemer (2008) and Jermann & Dillenbourg (1999, 2002), rated on four Likert-scale (0 to 6) answers on how they as teachers would assess the situation. The dimensions were balanced in the cases. Furthermore, the explorative factor analysis of the communication attitude questionnaire resulted in two independent factors similar to our theoretical construct of multi-perspective/flexible for the first factor (Cronbach's a = .87) and goal-oriented/structured for the second factor (Cronbach's a = .87) (see also, Puhl et al, 2015b). GAT and argumentation script, were implemented in closed Facebook groups, where participants engaged in argumentative discussions on the problem cases and could reference communication theories to support their arguments.

Table 1: 2x2 factorial design

	Argumentation Script	No Argumentation Script
GAT	*N* = 26	*N* = 24
No GAT	*N* = 30	*N* = 18

The *GAT* provided a graphical visualization of participants' attitude questionnaire results (Figure 1). The Facebook application included the visualization in order to increase socio-cognitive conflict (Jermann & Dillenbourg, 1999) by making attitude differences salient. Students were asked to reflect on these. Browsing the GAT was obligatory, but reflection was not controlled. Participants in *argumentation script* conditions had to "like" the best argument made by peers. Additionally, they received weekly feedback in the form of argument analysis on the epistemic (theoretical concepts and relations) and the formal (reasoning and evidence) argumentation quality for the most "liked", and for the instructors' favorite argument. These analysed arguments should be used as models in subsequent sessions. The control group received no additional guidance and was only required to hold discussions in their Facebook group. Discussion threads were organized based on posting time (last one on the top) and not on the number of "likes".

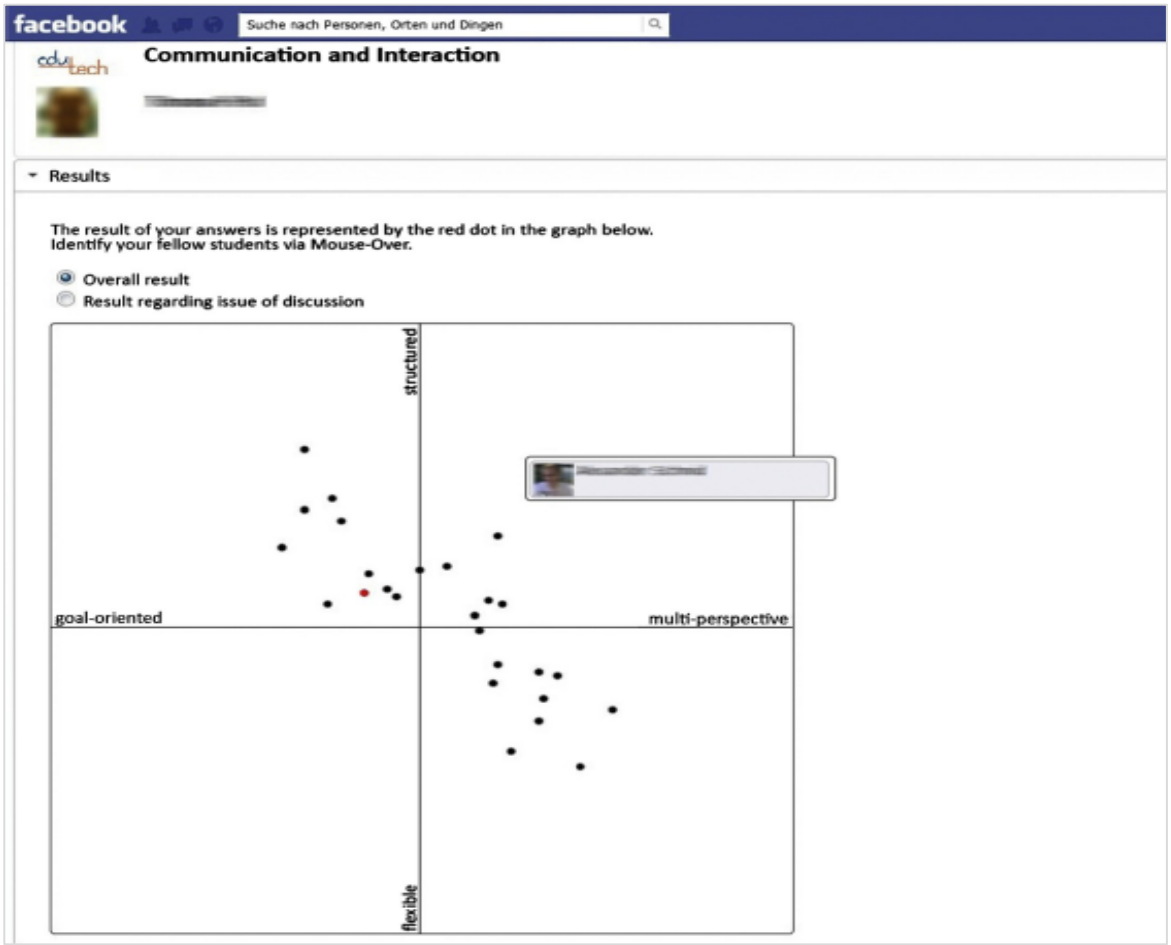

Figure 1. Group Awareness Tool in Facebook.

Social network analysis and hypotheses

We formed a network for the participants in each SNS discussion group using *Prominence-based placement* to visualize the group as a social network, such that each node (participant) position is a reflection of its centrality inside the network and their interactions are represented using the edges. To measure interactions, the number of outgoing posts and the number of incoming replies to every post by each participant of the group was recorded. The communication attitude questionnaire was used to record attitude of each participant after each discussion. We use SNA techniques to model attitude change and mutual weight balancing in the communication network formed by participants during discussions. Centrality measures obtained through the network are then used to assess intra group characteristics of participants affected by the use of experimental conditions in terms of their prominence based placement regarding attitude change. Thus, centrality is indicative of the importance of a particular participant in the discussion group. That is the participant is important for the proper propagation of information in the whole group and is, thus, a key member during discussions. If a particular group has more key members then that signifies an even distribution of influence, importance and information in the group, which helps in increased idea exchange and knowledge co-construction.

Additionally, the similarity in attitude reached by participants in each group is assessed using *density based clustering (DBC)* (Ester, Kriegel, Sander & Xu, 1996) instead of the more commonly used *clustering coefficient,* as the latter measures simply the tendency of a group's ability to cluster together. However, DBC measures the density of a group and thus, the information about how close the participants are regarding their attitudes after the discussions. We use measures of graph theory and network analysis (Freeman, 1978; Stephenson & Zelen, 1989; Wasserman & Faust, 1994; Ester, Kriegel, Sander & Xu, 1996) to operationalize our dependent variables in SNA (see Table 2), which are generated for each of the participating groups (experimental and control group) using programming and network analysis software (SocNetV1.9). The generated data was then empirically analyzed in SPSS and a 2×2 factorial ANOVA with conditions GAT (GAT, no GAT) vs. argumentation script (ARG, no ARG) as between-subjects factors was conducted to analyze the effects, differences and interactions introduced by the GATs and the argumentation script conditions.

Table 2: Operationalisation of SNA measures

Dependent Variable	**SNA Operationalization**
Number of interactions	The sum of incoming and outgoing interactions for each member of a group measured across time.
Information flow control (information centrality)	The proportion of total information flow that is controlled by the participants of the network (each group member). It uses the distance between two nodes, traversing the attitude values (Euclidean distance over time) of all nodes that mediate these two nodes.
Influence of individual attitudes on the group's attitude (*outdegree centrality)*	The effect of one member's interactions on the magnitude of attitude change of other group members over the course of the seminar; where influence is quantified as the weighted outgoing interactions of the participants.*
Influence of the group on individual attitudes (*indegree centrality)*	The effect of the group's interactions on the magnitude of attitude change of each individual participant throughout the seminar, where influence is quantified as the weighted incoming interactions on each individual participant.*
Attitude similarity (*density based clustering)*	The quantification of the closeness of group members to the center of the communication network w.r.t. their attitudes, where attitude similarity within a group is measured as their respective cluster density. **

* For example, if there are three participants in a group discussion, A, B and C, and "A" posts a view on the scenario and both "B" and "C" read it but only "C" replies once, then each participant might display a small change in their attitude by reading the discussion post alone. Therefore, a small weight of 0.1 is assigned. However, "A" and "C" is expected to have a major effect on each other's attitude due to the exchange of posts ,so their weights would be represented as the relative attitude change between them, calculated as the Euclidean distance between them w.r.t the two dimension of the communication attitude questionnaire, and distributed in the network using uniform probability distribution. Therefore, if the euclidean distance between the attitude change of "A" and "C" is 4 and 6 in the two dimensions, then their relative weight would be 5.1 and the total weight of "B" would be 0.2 .

** Calculated using the density based clustering algorithm (Ester et al., 1996).

We hypothesize that, the GAT, the argumentation script, and their combination will foster network measures when compared to the control group due to increased awareness and externalization of attitude differences and thus increased engagement shown in higher number of interactions (H1). Additionally, the formation of new communication channels within the groups will lead to higher centralized control per person on the total information flow (H2); and also reflection on conflicts and attitude differences would thereof increase the distribution of individual influence on the magnitude of attitude change of the group (H3); and lead to higher distribution of the group's influence on the magnitude of attitude change of individuals (H4), due to an even distribution of people central to the network. Finally, the experimental groups will foster higher attitude similarity (H5), due to the above changes in group processes, which will lead to attitude co-construction.

Results

In terms of control variables, we found no significant differences between participants of the different conditions regarding computer use (hours per week; $F(3, 93) = 1.48, p = .22, \eta_p^2 = .05$, Facebook use (hours per week); $F(3, 48.49) = 1.11, p = .35, \eta_p^2 = .03$, familiarity on computers and SNS ($F(3, 94) = 1.99, p = .12, \eta_p^2 = .06$), knowledge on communication theories ($F(3, 94) = 1.57, p = .20, \eta_p^2 = .05$) and on either factor of attitude change – multi-perspective/flexible: $F(3, 94) = .30, p = .82, \eta_p^2 = .01$ or goal-oriented/structured: $F(3, 94) = 1.45, p = .23, \eta_p^2 = .04$.

To test our hypotheses, we run inferential statistics using the SNA measures. We found significant differences between the groups regarding total number of interactions, $F(3, 94) = 199.45, p = .00, \eta_p^2 = .86$. The argumentation script had strong effects on the number of interactions with, alone, $F(1, 94) = 479.70, p = .00, \eta_p^2 = .84$, and in combination with the GATs, $F(1, 94) = 119.96, p = .00, \eta_p^2 = .56$ (interaction effect). However, the GAT alone did not significantly affect the number of interactions between participants, $F(1, 94) = 0.52, p = .47, \eta_p^2 = .01$ (Figure 2). Also, there were significant differences between groups regarding information flow control, $F(3, 94) = 395.85, p = .00, \eta_p^2 = .93$. We found a strong significant main effect of the argumentation script, $F(1, 94) = 301.93, p = .00, \eta_p^2 = .76$ and the GAT, $F(1, 94) = 64.39, p = .00, \eta_p^2 = .41$, and a strong interaction effect, $F(1, 94) = 934.27, p = .00, \eta_p^2 = .91$, indicating a higher distribution of information in the network and participants displayed more centralized control over information flow (Figure 2).

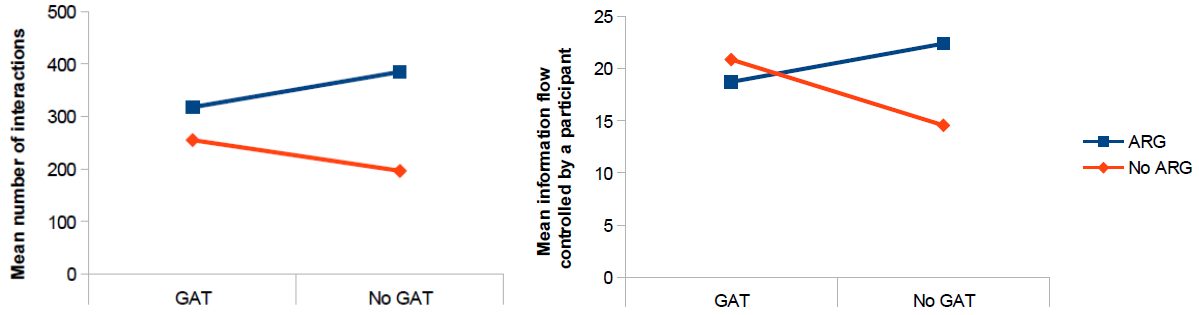

Figure 2. Total number of interactions and Information flow controlled by a participant measured by information centrality.

The analysis of the influence distribution in the network showed significant differences between groups regarding the effect of participant on group attitude change, $F(3, 94) = 39.31, p = .00, \eta_p^2 = .56$. There was a strong main effect of the argumentation script, $F(1, 94) = 106.18, p = .00, \eta_p^2 = .53$, and an interaction effect, $F(1, 94) = 15.49, p = .00, \eta_p^2 = .14$, that is there was an even distribution of individual influence in the network. However, there was no significant effect of GAT, $F(1, 94) = 1.60, p = .21, \eta_p^2 = .02$ (Figure 3). Additionally, there were significant differences between the groups regarding the centralized effect of group on participant's attitude change, $F(3, 94) = 275.21, p = .00, \eta_p^2 = .90$. We found a strong main effect of the argumentation script, $F(1, 94) = 743.34, p = .00, \eta_p^2 = .89$ and the GAT, $F(1, 94) = 11.22, p = .001, \eta_p^2 = .11$, and a strong interaction effect, $F(1, 94) = 108.44, p = .00, \eta_p^2 = .54$, that is there was an even distribution of group influence over the attitude change of individual participants in the network (Figure 3).

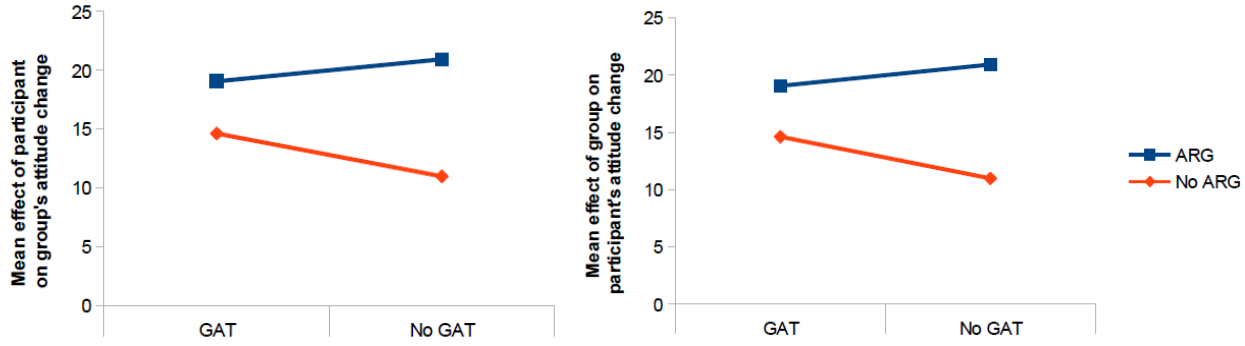

Figure 3. Effect of participant on group's attitude change and Effect of group on participant's attitude change measured by outdegree & indegree centrality respectively.

There were significant differences between the groups regarding attitude similarity – measured as their respective cluster density, $F(3, 16.58) = 9.14$, $p = .001$, $\eta_p^2 = .26$. We found a significant main effect of the argumentation script, $F(1, 32) = 4.54$, $p = .04$, $\eta_p^2 = .12$, and an interaction effect, $F(1, 32) = 5.36$, $p = .03$, $\eta_p^2 = .14$, that is the intra-group attitude similarity was higher with the argumentation script fostering higher similarity among participants. On the contrary, the GAT, $F(1, 32) = 1.62$, $p = .21$, $\eta_p^2 = .05$ did not show significance regarding attitude similarity (Figure 4).

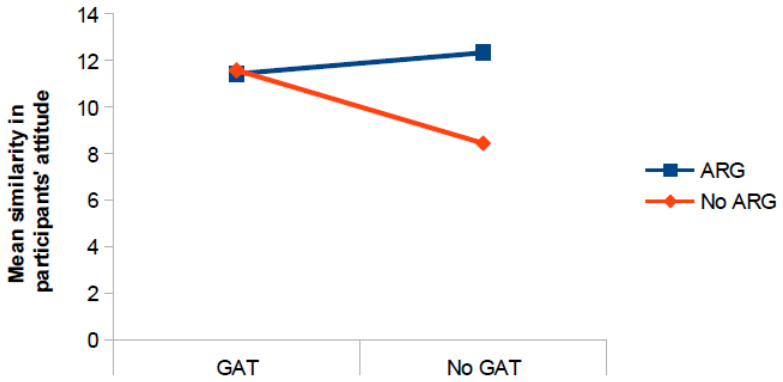

Figure 4. Similarity in participants' attitude measured by DBC.

Discussion and conclusion

The presented study uses SNA to provide a group-level analysis of SNS group interactions on learners' attitude change. It is one of the few studies to our knowledge (Puhl et al, 2015a; 2015b) that considers attitude change not as a byproduct of discussions but as a learning outcome in itself in monitored educational settings. The study also moves beyond individual-centric considerations of the knowledge co-construction process and provides a group-centric perspective, to do justice to the theoretical origins of knowledge co-construction. We defined and analyzed internal group dynamics during group discussions in SNS and their subsequent effects on the attitude change and its relation to knowledge acquisition of the learners using a combination of SNA measures and inferential statistics.

The results revealed that group level processes – number of interactions, information and influence distribution, and similarity in peer attitude – were all influenced by the argumentation scripts and by its combination with the GAT, and some were also influenced by the GAT alone. These supports cater for a more equal distribution of information flow and influence distribution. Distributed and centralized control per participant was facilitated by the argumentation script. Together with the effects of the argumentation script on attitude change, this result suggests that increased centralized control of learners on group processes may have led to a better representation of individual attitudes and may have thus facilitated information and opinion

exchange. We had hypothesized that facilitating centralized control for more learners in group discussions would cater for more attitudes becoming transparent in the group, strengthening attitude co-construction, and that it would lead to similarity in attitudes. Centralized control of information in the GAT groups facilitated representation and promotion of individual attitudes and increased the interactions compared to the unsupported group. However, centralized control of information *(H2)* did not initiate meaningful resolution of conflicts and therefore attitude similarity due to mutual change was to not observed in the GAT groups *(H5)*.

The results also suggest that the argumentation script either alone or combined with the GAT increased interactivity, despite the fact that GAT alone did not *(H1)*. This is a possible indication that the GAT may have instead taken over the role of promoting attitude externalization otherwise promoted by argumentation scripts. It also indicates that conflict awareness, does not necessarily lead to conflict resolution. Moreover, the results suggest that the cognitive guidance provided by the argumentation script might have prompted learners to resolve conflicts constructively and thus reach consensus regarding attitude dissimilarity. This cannot be a case of group bias (Sassenberg & Boos, 2003) or quick consensus building (Weinberger et al, 2007), as it is unlikely that these would have led to the observed increased interaction. The GAT alone, however, may have fostered group bias without the additional argumentative processes promoted by the script that further allow reflection on attitudes. The results, thus, proclaim the necessity to combine the conflict awareness provided by GATs visualizations with structuring interactions via argumentation scripts in order to enhance and encourage meaningful exchange of opinions and arguments during SNS discussions and promote conflict resolution.

In conclusion, the interaction network formed during group discussions identifies the potential of GATs and argumentation scripts to utilize the rich context of socio-cognitive interactions provided by popular SNS during argumentative discussions, in order to support pluralistic exchange and attitude change. SNA measures can be helpful in understanding the interdependence of learning objectives on individual's interactions and group communication and, thus, also for understanding the relative effects of learning interventions. However, SNA measures are a combination of several mathematical computations and lack an intuitive interpretation, posing a fundamental dependency on the framework and interpretation of the research subjected to the used measures. Nevertheless, the ability of SNA to incorporate multiple dependencies during analysis can be crucial to the examination of learning supports in the wild in contrast to monitored course settings and can be essential in gaining meaningful insights into the long term societal influences that SNS discussions may trigger.

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