Social and Cognitive Group Awareness to Aid Argumentation About Socially Acute Questions on Social Media

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Abstract: Debates about socially acute questions (e.g., migration) may help develop argumentation skills. However, students may be hesitant to present different views to maintain interpersonal relationships, hindering communication and integration of multiple perspectives. Social networking sites (SNS) have been used to extend classroom discussions to such real-world topics. However, their flat-structured layout may not suit argumentation activities. This quasi-experiment in an applied classroom setting investigates the effects of a group awareness tool (GAT) that combines social (group members' names) and cognitive (discussion points/ stance in initial arguments) information in a network graph to aid communication behavior and integration of multiple perspectives during argumentation on a flat-structured SNS. Students supported by the GAT engaged in discussions with non-friends and students outside their class more than the control group, though the latter integrated multiple perspectives more. The GAT appears to have increased familiarity among non-friends. The potential influence of interpersonal relationships on integration of multiple perspectives is discussed.

Introduction

Interpersonal relationships have been found to influence learning outcomes, especially when it comes to discussions about *socially acute questions* (SAQs): social dilemmas that are often controversial and that have implications on several fields of knowledge (Simonneaux, 2007). Students tend to be exposed to media representations of SAQs that are socio-sociological (e.g., immigration, globalization) or socio-scientific (e.g., global warming, cloning) in nature, which means that students may already have personal opinions about these issues (Zeidler & Nichols, 2009). Thus, introducing SAQs in the classroom provides an opportunity for differing views to emerge, and therefore for argumentation skills to develop. However, given the controversy that often surrounds SAQs, students may be hesitant to express disagreement in the interest of maintaining harmonious interpersonal relationships (Kuhn, Wang, & Li, 2010). This is a challenge because demonstrating and acknowledging awareness of opinions and perspectives other than one's own is a marker of good argumentation quality (Sadler & Donnelly, 2006). In order to develop argumentation skills, students should be exposed to multiple perspectives through social interaction and discourse in order for them to evaluate claims, analyze evidence, and make informed judgements about these issues (Simonneaux, 2007; Leitão, 2000).

Recently there has been growing interest in the use of social networking sites (SNS) such as Facebook and Google Community to support discussion and mutual learning between students (Manca & Ranieri, 2013). One big motivation for teachers to adopt SNS in their classroom is to have a platform to discuss real-world issues related to the current lesson (Chen & Bryer, 2012). This suggests that social media may be an appropriate platform to discuss SAQs. However, since many SNS platforms were built for commercial rather than learning purposes, they may lack structural features that promote meaningful discussions between learners. Kirschner (2015) particularly criticized the "flat structure" arrangement of discussions on SNS: that is, unlike hierarchical and threaded discussions, posts on a typical SNS appear all in one page in reverse chronological order, with replies to each post appearing un-nested below each post. This makes it difficult to find one's own postings, let alone those of others (Kirschner, 2015). In an argumentation activity, this could make it difficult for learners to become aware of others' discussion points and to connect their claims to the arguments of their peers. To overcome this limitation, group awareness tools (GATs) could be designed to provide information through visualizations about members of a learning group to implicitly aid individual learners to behave, communicate, and reflect in ways that are productive for collaboration and learning (Janssen & Bodemer, 2013). This information can be broadly categorized as (1) social/behavioral awareness, such as who are the group members, who they are communicating with, or how they are contributing to the task; or (2) cognitive/knowledge awareness, such as the level of prior knowledge of group members, the information that they possess or opinions that they hold. When GATs are designed to allow for comparison of one's knowledge or behavior to that of their peers', learners may adapt their actions accordingly. For example, GATs that highlight knowledge differences led learners to communicate with their peers to fill their knowledge gaps (Erkens, Schlottbom, & Bodemer, 2016) or to discuss perceived conflicts with peers in a more interactive way (Bodemer, 2011).

Studies about GA support specifically for social and attitudinal characteristics of group members during argumentation in SNS have yielded some promising results. In a series of controlled lab experiments, Tsovaltzi and colleagues supported group awareness on a Facebook-like platform by informing participants, as they were preparing their individual arguments prior to collaborative discussion, that their arguments may be published after completion of the experiment for other students to comment and amend. In one study (Tsovaltzi, Puhl, Judele, & Weinberger, 2014), they found beneficial interaction effects on individual argument elaboration when combined with argumentation scripts, but a detrimental main effect on learning. In another study, they additionally found that group awareness did not lead to considering multiple perspectives (Tsovaltzi, Judele, Puhl, & Weinberger, 2015). The researchers hypothesize that group awareness in this case led to overcautiousness whilst constructing their initial arguments, which led to more individualistic behavior. Puhl, Tsovaltzi & Weinberger (2015) found that displaying in a 2-dimensional space the communication attitudes of the group members' relative to one's own attitudes led to gains in domain knowledge and a change of attitude towards multi-perspective communication.

Previous work suggests that the interpersonal relationships between students may have an influence on their awareness of multiple perspectives, which is essential for successful argumentation. Although previous GAT research in argumentation in SNS have demonstrated some promising effects, none so far have addressed overcoming the "flat-structuredness" of SNS by bringing awareness to the diversity of arguments in the community and enabling comparison of one's opinions to the opinions of others. The present study investigates the effects of a GAT that attempts to address these concerns: by combining social information (names of group members) and cognitive information (discussion points and stance of each group member) in a network graph to aid argumentation on a flat-structured SNS. Particularly, the influence of GA support on communication behaviour, learning outcomes, shifts in opinions, awareness and integration of multiple perspectives are evaluated in a SNS in applied classroom setting, which is different from most GA studies on argumentation in SNS which are usually conducted in laboratory settings (Tsovaltzi et al, 2015; Bodemer, 2011). In addition, the study also describes how users interact with a GAT arranged in a network graph and what these interactions imply about how the information contained in it is processed productively.

Method

Design and participants

A quasi-experiment was conducted with twenty-nine Year 12 students (*mean age*=17.2, *SD*=.45) in two Economics classes with the same teacher in an International Baccalaureate (IB) school in Germany. Because the experiment sessions were embedded as classroom activities, the research design was selected in the interest of ecological validity and in order not disrupt the remaining class time. One class (n=14) was randomly assigned as the control group and the other (n=15) was assigned as the GAT (i.e., experimental) group. Their final Economics grades in Year 11 (7 is the highest possible grade) shows that prior academic performance between the control (M=6.2, SD=1.17) and GAT (M=5.86, SD=1.1) groups is similar. In terms of English language ability, most of the students are placed in English A class (native/native-like speakers), except for 1 student in the control group and 3 students in the GAT group. However, the teacher believes that both classes are competent in academic English, and the English B students perform well in their economics classes. Six Year 12 students (all 17 years old) from an IB school in Australia also took part in the experiment as a classroom activity and interacted with participants; however, due to technical difficulties their data was excluded from the analysis.

Social media learning environment, learning activity and instructions

The social media platform used for the study is called Google+, an SNS created by Google, which allows users to create "Communities" in which users can engage in asynchronous discussions about specific topics. The format can be described as flat-structured (e.g., posts appear chronologically and replies to posts were not nested). This platform was selected by the IB Economics teacher as it could be easily integrated into the students' existing web tools, since all student email addresses were hosted by Google's email service Gmail, which is required to access Google+. The teacher created a private Google Community for his 2 Economics classes, as well as the economics class of a former colleague in Australia, to provide a platform for debates about real-world issues related to economics. Apart from a brief session in which each student had to post a short self-introduction, participants had no prior experience with Google+ before the experiment sessions.

Four experiment sessions were integrated as class activities in 4 separate 50-minute Economics class periods over the course of 4 weeks (1 session per week). Both groups completed Sessions 1, 3 and 4 on the same days. Due to some technical problems, Session 2 for the GAT group was postponed to the day after the control group completed Session 2. No class was allowed to proceed to the next session until all students have

participated in the current one. Students worked on the experiment sessions on their own computers and were not allowed to engage in off-task behavior or speak to their classmates. They were also not allowed to interact on Google Community outside experiment sessions.

The first 3 experiment sessions corresponded to the knowledge building cycle proposed by Leitão (2000) whereby students first (1) construct an initial argument (Session 1); (2) have the opportunity to construct a response/counterargument (Session 2); and (3) construct a reply to responses they received and revise initial argument (Session 3). "Migration" was selected as the topic for discussion for its relevance to the Development Economics unit of the IB Economics syllabus and informal observations that suggested a diversity of perspectives among the students. In Session 1, each student was asked to create a post on Google Community with a 4-6 sentence argument to the question: "To what extent do you agree with the statement: 'Migration from developing to developed countries leads to economic development.'?" Each post had to (1) mention at least 1 economic stakeholder and whether it benefits from migration; and (2) had to be supported by at least 1 article from a credible online resource (students were provided with links to appropriate sources). In Session 2, both control and GAT groups were given the same instructions to follow when commenting, namely (1) comment on at least 1 post; (2) structure comments around their initial arguments in Session 1; (3) if they hold the same perspective, write down exactly what they agree on and why; (4) if they hold a different perspective, write down exactly what they disagree on and why; (5) ask questions if something is not clear or if they would like more information; (6) give feedback or suggestions and explain why they think this could be helpful. Students were also explicitly instructed to read as many posts as they can before commenting, as well as how to use the "Search" function to find posts by specific people, so that they do not simply comment on the first post they see. In Session 3, students were instructed to (1) add to or edit their Session 1 argument if their perspective has changed, or to write new 4-6 sentence response to the initial question; or (2) write about why their perspective has stayed the same. In Session 4, students answered a survey about their experience during the experiment.

Group awareness tool

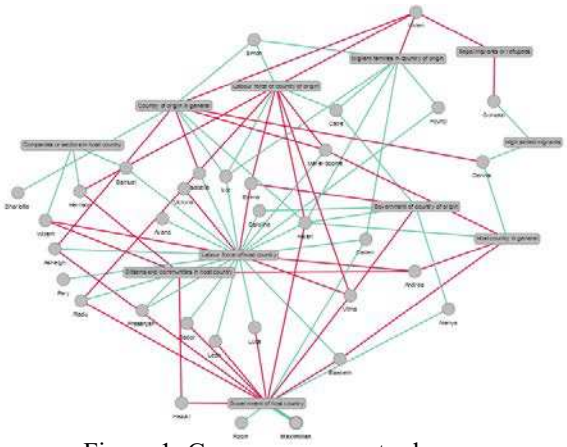

Figure 1: Group awareness tool.

The GAT provided to the GAT group visualizes how each student's initial argument (Session 1) is positioned with respect to the opinion/responses of their peers (see Figure 1). The tool is a network graph composed of *2 types of nodes*: (1) *students* (circles); and (2) migration *stakeholders* (rectangles). An *edge* is drawn between these 2 node types *if the student mentions that stakeholder* in their initial argument, with the *color (green or red) indicating the stance* of the student (whether it benefits or does not benefit from migration, respectively). Two coders jointly identified 11 stakeholders from the initial arguments and independently coded the stances (Cohens' k=0.86). The network graph was then created using the R package visNet that produced an interactive graphic that allowed users to click and rearrange the graph elements. The following clickstream data was logged by the tool: *drag view* (i.e., zooming, panning and scaling the view of the graph), *click node, drag node, click edge, drag edge.* The tool itself is hosted on a separate URL and was not integrated on Google Community. Therefore, students had to keep two browser windows open during the experiment sessions (one for the tool, one for Google Community). The tool was intended for students in the GAT group to help them select which student (posts) to reply to in Session 2, based on their initial arguments on the discussion topic in Session 1. Somewhat similar to the GAT of Puhl et al (2015) on a 2D space, the networked arrangement of students and stakeholders (i.e., discussion points) allows not only a general overview of the initial arguments in the entire community, but also enables individuals to compare their arguments to those of others based on their connections (or lack thereof) to the same stakeholders. Based on previous GAT research that also enabled users to compare their information to others (e.g., Erkens et al, 2016), this arrangement along with the color-coded edges should help students to easily identify differences between stances on the same stakeholders and use it as a point of discussion. Thus, in order to overcome the flat-structured layout of Google Community, the GAT was designed to influence communication behavior on the basis of social (names of group members) and cognitive information (discussion points and stance of each group member), specifically with regards to differences in opinion.

Procedure

In *Session 1*, students were first given 5 minutes to answer a survey that asked for their opinion on specific migration stakeholders (see "Measures…" section). Then they were asked to create individual posts on Google Community with their initial arguments regarding the topic of migration, as stated in the "Social media learning environment…" section. Students were also encouraged, but not required, to use the sentence starter "I agree/do not agree with the statement…". Students were given 15 minutes to post their initial arguments. In *Session 2*, the *control group* proceeded to read and comment on their peers' posts on Google Community for 15 minutes, whereas the *GAT group* was first introduced to the GAT in two phases. First, students were trained on how to interpret the GAT using a small-scale version with dummy data and were prompted to identify student pairs that had the same/different opinion on the same stakeholder. Second, they viewed the GAT and were instructed to find their name and compare their Session 1 arguments with the arguments of their peers. They were explicitly told that the GAT is interactive, and that they could click and drag the graph elements. Students were then asked in a survey to identify at least 1 student that shared/did not share their opinion on the same stakeholder. They were given 5 minutes for the training phase and 10 minutes to explore the GAT, before being given a further 15 minutes to comment on at least 1 of their peers' posts on Google Community, just like the control group (the tool was made available to them during this time). In *Session 3*, students were instructed to read their Session 1 arguments and reflect on whether their perspective has changed since reading, commenting and receiving comments on their posts. Then, in the form of a comment on their Session 1 post, they were instructed to revise their initial opinions and respond to the comments they received. They were given 15 minutes to complete Session 3. *Session 4* was a post-study questionnaire that asked students about their experiences in the Google Community activity (see "Measures…" section).

Measures, research question, and hypotheses

Communication behavior is defined as how students chose to reply to certain posts over others on Google Community in Session 2. The initial opinions of each student as expressed in Session 1 (i.e., stakeholders mentioned and stance) were compared the initial opinion of the student that they replied to in Session 2, and categorized as having: (1) the same opinion on at least 1 stakeholder; (2) a different opinion on at least 1 stakeholder; or (3) having no shared opinion on a stakeholder. Students were also asked to indicate who among the students in the Google Community they would consider as their friends to check whether *friendships* had any influence on their communication behavior. *Integration of multiple perspectives* was based on Leitão's (2000) description of the impact of others' perspectives from the discussion on one's initial argument: multiple perspectives can be dismissed, localized (alternative perspectives are acknowledged but the initial argument is retained), integrated with initial opinions (e.g., allowing for some exceptions or conditions), or fully accepted. The final arguments were coded accordingly by two coders (kappa=.76).

To measure *learning outcomes*, the teacher administered two practice exams for IB Economics (as is standard practice in the school) before Session 1 and after Session 4. These covered topics from the Development Economics unit of the IB Economics syllabus. One question (worth 8 points) required students to apply their economics knowledge to evaluate a reference news article (pre-test: the impact of the involvement of China in Ethiopia's economy; post-test: strategies that the Haitian government can use to improve their economy). As stated in the grading rubric, to successfully answer the essay question "students must offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence". Therefore, students were required to apply the same argumentation skills in both the exam question and the experiment sessions.

Another measure administered before and after the experiment was *opinions on migration stakeholders.* In Session 1 (before posting initial arguments) and Session 4, students rated 8 economic stakeholders of migration in both the host (developed) country and country of origin (developing) according to whether migration negatively or positively benefits them (1 – very negative impact to 5 – very positive impact). *Awareness of the multiple perspectives* was evaluated in Session 4 by asking students, for each of the 11 stakeholders appearing on the GAT, whether they perceived the overall opinion in the community of the impact of that stakeholder on migration as mostly positive, negative, or rather well-distributed between the two stances. One point was given for each correct answer for a total of 11 points. In addition to the dependent variables and the clickstream data logged by the GAT, *self-reports on the experiences of the GAT group with the GAT* were collected in Session 4. Students were asked to rate (1 – strongly disagree to 5 – strongly agree) 4 statements pertaining to the usefulness of the GAT in (1) representing their initial argument; (2) providing them with an overview of the Community's opinion on migration stakeholders (3) helping students identify which of their peers agreed/disagreed with their opinions; and helping students decide which posts to (3) read and (4) comment on in Session 2. Participants were also asked to *assess their own change in perspective*: whether their

perspectives (1) completely changed, (2) did not change at all, (3) changed by integrating new perspectives with original ones, or (4) did not change, but they were able to acknowledge alternative perspective (i.e., localized, Leitão, 2000). They were also asked to specify the most influential source of their change in perspective.

Finally, several control variables were also analyzed to investigate how they may impact the findings on the dependent variables. First, *argumentation quality of initial arguments* in Session 1 were assessed based on whether a credible source was cited, as well as on Sadler & Donnelly's (2007) rubric on "position and rationale" for argumentation, specifically whether or not the claims were grounded ("offers a coherent, logically consistent argument that includes an explanation and rationale for his/her position", p. 1474). Second, *argumentation moves* in Session 2 responses were categorized as either as an (1) agreement; (2) disagreement (including local agreement) or (3) non-argumentative move (e.g., questions, off-topic comments). Finally, for each student, their initial argument in Session 1 and their reply to in Session 2 were compared to check *whether students used their initial arguments as a basis for their peer discussions*: (1) complete consistency; (2) partial consistency; and (3) not consistent at all. These variables were coded by two coders; Cohen's kappa is .88 for argumentation quality, .87 for argumentation moves and .94 consistency of comments to initial arguments.

The overall research question for the present study is: Can a GAT depicting (1) students (social information) (2) discussion topics and (3) opinion stances (cognitive information) foster argumentation and learning on a social media platform? It is hypothesized that students supported by the GAT will post arguments on posts that reflect a different opinion than their initial arguments (*communication behavior*) (H1); be more likely to demonstrate *integration* (H2) of multiple perspectives; will receive higher scores on *learning outcomes* (H3); (2) and exhibit a greater *shift in opinions* on migration stakeholders (H4), and demonstrate better *awareness* (H5) of multiple perspectives.

Results

Table 1: Sample size per experiment session and final sample size associated with each variable

	Control	GAT	Total	Variables analyzed with this sample size
Class size	14	15	29	None
Session 1	13	14	27	Argument quality
Session 2	13	13	26	Communication behavior; argumentation moves; consistency of comments to initial argument
Session 3 and Session 4	12	13	25	Number of friends; learning outcomes, opinion shifts; (1) awareness and (2) integration of multiple perspectives; self-reported perspective change

Some students were unable to complete all experiment sessions due to absences. Thus, Table 1 summarizes the final sample sizes for each of the measured variables. The 6 Australian students participated in Sessions 1-4. However, in Session 2 they mostly interacted with their fellow classmates, except for 2 students who replied to 1 student in each group. Therefore, their influence on the data is expected to be minimal.

Descriptive information on Session 1 (initial arguments) and Session 2 (comments)

A total of 33 initial arguments were posted on Google Community in Session 1 (27 from the experimental groups and 6 students in Australia). The *quality of arguments* was quite high among most students: both groups were able to make well-grounded claims in their initial arguments (p=1.00, Fisher Exact Test). On average, students in the control group mentioned 2.7(SD=.99) out of 11 stakeholders, of which they took a "benefits from migration" stance for 1.7 (SD=1.49) stakeholders and a "does not benefit" stance for 1(SD=.88) stakeholder. The GAT group mentioned 2.23 (SD=1.59) stakeholders, of which they took a "benefits from migration" stance for 1.69 (SD=1.37) stakeholders and a "does not benefit" stance for .54 (SD=.78) stakeholder. The mean difference of the two groups on their "does not benefit from migration" stance on stakeholders was significant (Mann Whitney U=48.5, p=.029, r=-.419), indicating that the control group was more likely to express this stance in their initial arguments than the GAT group. In Session 2, control group received on average 1.08(SD=1.24) comments and the GAT group received 1.15(SD=.9) comments. However, not all students were able to receive comments on their posts: 5 from the control group and 3 from the GAT group. In terms of *argumentation moves*, the proportion of students that wrote counterarguments in their comments was 0.62 in the control group and 0.38 in the GAT group, although this difference was not significant (p=.546, Fisher Exact

Test). Both groups were also *equally likely to use their initial arguments as the basis for the comments* ($\chi^2(1)=.653$, $p=.419$).

Dependent variables

In terms of the *learning outcomes*, mean pre and post-test scores for the control group are 4 (*SD*=1.1) and 3.83 (*SD*=1.6); for the GAT groups, mean pre and post-test scores are 3.31 (*SD*=1.3) and 4 (*SD*=1.6), respectively. However, a mixed ANOVA yielded no significant interaction effect between time and the presence/absence of the GAT ($F(1, 23)=1.626$, $p=.206$). Analysis of *communication behavior* in Session 2 also did not yield any significant group differences ($p=0.667$, Fischer's Exact Test). Both groups were equally likely to comment on peers' posts that expressed the same opinion as theirs (and had no differing opinions) on the same stakeholder (control=6, GAT=8). However, students in the control group were 12.6 times more likely to comment on friends' posts than students in the GAT group (95% C.I.: 1.19, 678.9, $p=0.03$, Fisher Exact Test). Furthermore, the odds that students would comment on posts written by their classmates were also 5.33 higher if they belonged to the control group ($\chi^2(1)=4.06$, $p=.044$). This finding is interesting considering that both groups tended to have friends from within and outside their classroom. The average *numbers of friends in the same class* were 3.5(*SD*=1.9) for the control group and 4.46(*SD*=2.9) for the GAT group, though this difference was not significant (Mann Whitney $U=69.5$, $p=.63$). In terms of *friends in the other Economics class,* the average numbers are 2.25 (*SD*=1.86) and 3.85(*SD*=2.82) for the control and GAT groups, respectively, although the difference is non-significant as well (Mann Whitney U=48.5, $p=.104$). A factorial ANOVA with aligned ranks transformation yielded no significant interaction effect between time (pre-test/post-test) and the presence/absence of the GAT in terms of *shifts of opinions* regarding the 16 rated stakeholders ($p>0.05$). In terms of *awareness of multiple perspectives*, the mean score for the GAT group was 5.8 (*SD*=1.1) and the control group mean score was 5.2 (*SD*=1.6), although the difference is non-significant (Mann Whitney $U=53.5$, $p=.171$). Finally, for *integration of multiple perspectives*, the final arguments of the students fell into only 2 out of the 4 categories in Leitão (2000): integration and dismissal. A chi-square test of independence revealed that the odds of students integrating multiple perspectives from the discussion in their final answers was 6.67 higher if they were not supported by the GAT than if they were ($\chi^2(1)=4.98$, $p=.026$). However, according to *self-reported change in perspective*, only 2 students in each group reported that their perspective "did not change at all". The self-reports also indicate that of the 21 students who reporting integrating new perspectives, 10 of them (control=4; GAT=6) that reading other students' posts was the most influential in their change of opinions in the final answer; followed by comments received on their posts (mentioned by 3 students in each group).

How the GAT group made use of and perceived the group awareness tool

In Session 2, the GAT group spent an average of 3.72 minutes (*SD*=1.9) exploring the GAT. There were 240 recorded interactions, most of which (84.6%) were of students zooming into, panning and scaling the view of the graph. This means that it is not possible to determine from the log data which elements of the graph students were paying attention to, or whether they noticed similarities and differences between student opinions. However, in the training phase in Session 2, all 14 students were able to correctly identify student pairs from the dummy data that had the same/different opinion on the same stakeholder. All 14 students were likewise able to correctly identify from the GAT at least 1 student each that shared/did not share their opinion on the same stakeholder, although only 5 students actually posted on the posts by the students they identified. In Session 4, the GAT group gave neutral to positive ratings on the usefulness of the tool. Students gave positive ratings to the statements "I was able to see which members agreed or disagreed with my perspective" (*M*=4.38, *SD*=.77) and "The graphic helped me gain a general overview of the perspectives of other members in Google Community" (*M*=4.3, *SD*=.85). However, they gave neutral ratings when asked how well they believe the tool represented their perspective (*M*=3.62, *SD*=.76) and whether the tool helped them decide which posts to read (*M*=3, *SD*=1.2) and comment on (*M*=3.30, *SD*=1.38) in Session 2. When prompted to explain their ratings, 7 students mentioned that seeing who shared or did not share their opinions on the same stakeholder helped them decide which posts to comment on. One student noted that the graph helped her find posts that talked about stakeholders that she did not mention in her initial argument. The remaining 5 students mention that they did not take the tool in consideration when deciding on posts to comment on, stating that it was confusing, provides little information and that it was difficult to remember which students agreed or disagreed with them.

Discussion

The present study investigated a GAT for argumentation about a socially acute question on a flat-structured SNS, which is often criticized as not being conducive for argumentation activities. Like previous GAT designs for argumentation in SNS, it attempted to provide both an overview of group information and encourage

comparison of one's information to others. In this study, however, the GAT combines two kinds of GA information (social and cognitive) and was designed to guide a specific phase in the activity, whereby students must select peer group members to discuss their opinions on migration with. This was an important consideration given that prior to the experiment, the participants already had relationships with each other, as well as opinions about migration, which could influence how they behave during argumentation activities.

In terms of communication behavior, no significant differences were found on the dependent variable measured (H1): both groups mainly conversed with students that expressed the same initial arguments as theirs on at least one stakeholder. It should be noted that both groups were equally likely to express approving and dissenting opinions during discussion. This could imply that discussions among students probably went beyond the topics (stakeholders) that they had in common. Based on the log files, interactivity with the details (e.g., nodes and edges) of the GAT was quite low, even though students were explicitly told that they could interact with the graph. Thus, it is likely that the GAT group did not deeply process the commonalities and differences between them and their peers. However, subjective ratings indicate that students supported by the GAT may have noticed the differences in perspectives in the group. Furthermore, students were able to correctly interpret network graphs with dummy and real data; thus, the networked visualization itself was not too complex to comprehend. However, from a technical perspective, clicking a name or stakeholder (nodes) as well as their stance (edges) did not automatically redirect users to the corresponding posts on Google Community, which could have discouraged the GAT group from interacting in Session 2 in accordance to the GAT. Nevertheless, despite having friends in both classes, students in the control group overwhelmingly decided to respond to their friends in the same class, whereas students in the GAT group were equally likely to comment on friends' and non-friends' posts. The control group's behaviour is consistent with studies showing that people tend to be more willing to express their opinions online to friends (Luarn & Hsieh, 2014). Studies have shown that unfamiliarity with community members demotivates active participation in online discussions (Preece, Nonnecke, & Andrews, 2004) and that familiarity increases the likelihood of participation in online discussion forums (Hew, Cheung, & Ng, 2010). Given that the most dominant action captured by the GAT is zooming, panning, and scaling implies that the GAT group paid more attention to the GAT as a whole, without dwelling too long on any finer node-edge relations. It is possible, then, that they were able to get an overview of who is in the community and which stakeholders they had an opinion about. Hence, the GAT may have created a sense of familiarity among the students and help them consider the posts of peers that they are not personally close to.

Another finding of the study is that the control group was more likely to integrate multiple perspectives from the discussion than the GAT group (H2). Since not all students in the control group received comments on Session 2, the integration of multiple perspectives could not have only been the result of receiving comments containing a different perspective; as suggested by the self-reports, reading posts with dissenting opinions may have also had an influence. However, the study was not able to track which posts were read by whom and whether the GAT influenced this behavior. Nevertheless, other studies have suggested that opinion change is influenced by the relationship of a person with their communication partners. People are more inclined to change their opinion when exposed to the opinions of people who are closely related to them; specifically, any dissimilarity in initial opinions is reduced by social influence (Friedkin & Johnsen, 1997). Even when friends tend to have the same initial opinions, friends are still more likely to express disagreement anyway, which could foster learning from opposing perspectives (Morey & Hutchens, 2012). This could explain why the control group, who mainly commented on each other's posts, were more open to changing their initial opinions after being exposed to the opinions of friends. When people are not closely related, as in the case of the GAT group students, then the social influence process does necessarily influence any changes in initial opinions (Friedkin & Johnsen, 1997). Another explanation could be that there were more diverse opinions on migration among the control group's initial arguments, as they were found to be more likely to take a "does not benefit" stance than the GAT group. Thus, the control group could simply have been more open-minded and receptive to different views after discussion (Barabas, 2004). Furthermore, self-reports show that only 4 students (2 in each group) indicated that their perspective did not change at all. It is perhaps possible that more students in both groups were able to integrate or localize new perspectives from the discussion, but did not express this when they revised their opinions in Session 3.

Overall, the study demonstrates that combining social and cognitive information in a GAT with a network visualization may influence communication behavior, but not necessarily in accordance to awareness of differences in initial arguments. Rather, the GAT helped students find posts in a flat-structured SNS that were written by students with whom they do not have a close personal relationship, potentially increasing familiarity among students in the community. Building familiarity could be an important consideration for argumentation in SNS to encourage students to freely discuss controversial SAQs in a supportive environment. The results further suggest that communicating with friends and exposure to the opinions with whom one has a close

personal relationship may influence the likelihood of adopting new perspectives, although alternative explanations cannot be ruled out (i.e., that the control group could have been more open-minded). Thus, the seemingly contradictory results (i.e., familiarity may increase overall engagement among non-friends, but communication among friends may lead to more multiple perspective taking) could be further investigated in relation to other variables (e.g., open-mindedness). As these issues will continue to be relevant inside and outside the classroom, it would be beneficial to understand how to best encourage students to discuss socially acute issues in a meaningful way.

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