Social Cues in Asynchronous Online Discussions: Effects of Social Metacognition and New Ideas

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Abstract: This study examines how group members' social metacognition and new ideas in recent messages affected a current message's positive social cue (SC) or negative SC during asynchronous, online discussions. We modeled 894 messages by 183 participants regarding 60 high school mathematics topics (typically 8 people posted per topic) on a public, informal, mathematics problem solving website not connected to any class or school (www.artofproblemsolving.com) with a statistical discourse analysis. Results showed that group members' agreements facilitated positive SCs, while disagreements facilitated negative SCs. Meanwhile, new ideas and justifications were less likely to be accompanied by SCs. Together, these results suggest that teachers can foster student's construction of knowledge by encouraging polite disagreements during online collaborative learning.

Introduction

Students are increasingly using asynchronous, online discussions to aid their learning (Tallent-Runnels et al., 2006), in part because these discussions allow people to collaborate at different places and times–unlike traditional face-to-face (FTF) discussions. Researchers have focused on cognition during online discussions rather than social relationships (De Wever, Schellens, Valcke, & Van Keer, 2006). Moreover, researchers have not systematically examined the relationships among online discussion messages to characterize group processes that affect the likelihood of online SCs. SCs can indicate online authors' (*users*) affective states and attitudes toward others, which could in turn affect their social relationships and collaboration (Swan & Shih, 2005).

In this study, we take a step in this direction by examining how social metacognition and new ideas in recent messages facilitate or hinder a current message's positive SC or negative SC during online mathematics discussions. By understanding how users' discussion processes affect their use of SCs, educators can help students develop positive social relationships that aid their online collaboration and reduce negative SCs that may harm their collaborative learning (Garrison, Anderson, & Archer, 2000).

Theoretical Perspective

Positive vs. Negative SCs

The SCs in a discussion are not necessarily related to the problem content (Henri, 1992). Specifically, positive SCs can display users' positive affective states (e.g., "Oh, I get it now"; "☺") or show their positive attitude toward others when giving greetings, emphasizing agreement (e.g., "I *totally* agree with you!"), or showing appreciation (Brown & Levinson, 1987). Such positive SCs can help build a mutually respectful, supportive, and encouraging climate that promotes positive social relationships and collaboration in the problem content space (Garrison et al., 2000).

In contrast, negative SCs show users' negative affective states (e.g., "I'm so stupid"; "☹") or negative attitude toward others, such as rudeness ("You are wrong!!!") and flaming ("No, I'm not, YOU are wrong!!!"; Herring, 1994). Such negative SCs might create an aggressive or hostile environment that harms users' social relationships and hinders their collaboration. In this study, we examine how social metacognition, new ideas, and SCs in recent messages affect a current message's positive or negative SCs.

Social Metacognition and New Ideas

Like FTF discussants, users often use social metacognitive strategies to evaluate one another's ideas (agreement, disagreement, or neutral), recognize problems, and invite audience participations (question, command, or statement). When agreeing with previous ideas, users are likely to add positive SCs to emphasize their positive feeling and enhance their positive social relationship. For example, when agreeing with an idea, users who feel strongly about it might add extra affective words (e.g., "Aha, I agree with you") or emoticons (e.g., "Right ☺"), which parallel smiling agreements in FTF discussions. By emotionally supporting a previous idea, users enhance their solidarity and make the text-based discussion more enjoyable. Meanwhile, as agreements often indicate positive social relationship (Brown & Levinson, 1987; Chiu, 2008b), a user responding to an agreement is more likely to continue the positive social relationship (Walther, 1992), usually by adding a positive SC in the response.

In contrast, when users disagree with previous ideas, they might be less likely to add positive SCs in their messages. In online discussions, the anonymity and reduced face concerns allow users to disagree with one another more freely (Reinig & Mejias, 2004). Thus, users might be less likely to use positive SCs to soften or redress disagreements; or they might even add negative SCs to disagree rudely due to the reduced normative constraints of online discussions (e.g., adding exclamations, "No, you are wrong!!!").

Compared to FTF discussions, the larger pool of potential participants and the asynchronous nature of online discussions reduce the expectation that any one specific participant must respond any time soon or respond at all. Thus, users are likely to use a *negative politeness* strategy to reduce imposing on the target person to give him or her more freedom (*negative politeness* redresses the imposition of the speaker on the listener and is often used to make a request less infringing, e.g., "Could you…"; "It's kind of off-topic…"; Brown & Levinson, 1987). By using such positive SCs to express a question politely, users are likely to increase the possibility of receiving a satisfactory response.

Users are less likely than FTF discussants to use SCs when providing new ideas. Unlike FTF discussants, online users often do not know each other and have weaker social commitments, resulting in greater psychological distance among them (Chen & Chiu, 2008). Furthermore, online discussions filter out the nonverbal channels that are generally rich in interpersonal information. By focusing more on the problem content and less on the social relationships, they are likely to use fewer SCs in their new ideas. Likewise, as justifications (i.e., justified new ideas) facilitate calm, reason-based communication (Chiu, 2008a), users might focus more on the problem content rather than on their social relationships; hence, justifications are less likely to be accompanied by SCs.

In short, agreements might facilitate positive SCs, while disagreements might hinder them during online discussions. Meanwhile, questions are likely to increase positive SCs in the responses. Also, new ideas and justifications are likely to reduce the likelihood of SCs during online discussions.

Control Variables

Other factors such as users' previous recent positive and negative SCs, users' personal information (displayed gender [masculine, feminine, or neutral], number of past posts, initiator of topic), message number (bigger number indicates later posting), message length (number of words per message), and time interval between messages were entered as control variables.

Method

Participants and Data

In this study, 183 users discussed 60 mathematics problems in the High School Basics (HSB) forum on the Art of Problem Solving website (www.artofproblemsolving.com). Participants can communicate with one another as they wish, without teacher moderation or control. The target audience for the forum is students aged 12–16 from across the world.

Sixty mathematics problems were randomly selected from the HSB forum, excluding problems with less than 4 reply messages. These 60 problems received 894 reply messages. Each problem and its reply messages were linked to one another by multiple threads and single connections. See Table 1 for example messages responding to a mathematic problem.

Variables & Coding

In this study, the unit of analysis was the complete message posted on the online discussion. Variables for a single message included message number, message length, time interval between messages, user's number of past posts, and the following binary variables: agreement, disagreement, correct new idea, wrong new idea, new idea with unknown validity, justification, repetition, question, command, positive SC, negative SC, masculine, feminine, and initiator of the discussion topic.

Two students coded each message separately. Then, they settled all coding disagreements by consensus. The analyses use two sets of variables: current variables measuring properties of the current message (0) and lag variables measuring properties of earlier messages in the same thread (–n, where n = 1, 2, 3, 4). See Table 1 for coding examples.

Analyses

Statistical Discourse Analysis (SDA; Chiu, 2008a; Chiu & Khoo, 2005) separated unexplained error into message (level one) and topic (level two) components, thereby removing the correlation among error terms resulting from messages nested within topics. A Logit model properly models the binary outcome variable positive SC or negative SC. We used an alpha level of .05 for all statistical tests. Benjamini, Krieger, and Yekutieli's (2006) two-stage linear step-up procedure was used to control for the false discovery rate. We used Higgins and Thompson's (2002) I^2 index to modify the Ljung-Box Q statistics (Ljung & Box, 1979) for testing

serial correlation in the residuals of the regressions for all topics (Huedo-Medina, Sanchez-Meca, Marin-Martinez, & Botella, 2006). To facilitate the interpretation of these results, we converted the total effects (E) of each explanatory variable to odds ratios, indicated by the percentage increase or decrease (+E% or –E%) in the likelihood of an outcome variable (Kennedy, 2003).

Table 1: Coding of an online discussion segment on the problem: "how do you find x in x2 + 3x = 40?"

#[a]	IC[b]	Message	SC[c]	EPM[d]	IF[e]	NI[f]	J[g]	R[h]
1.	*Sue*; F; 1103	I got –8, 5. Try to factor with this formula: $ax^2 + bx + c = a(x - \frac{-b + \sqrt{b^2 - 4ac}}{2a})(x - \frac{-b - \sqrt{b^2 - 4ac}}{2a})$	N	*	_.	√	J	T[i]
2.	*Jim*; M; 107	I checked with the formula, –8 and 5 are correct :-)	☺	+	_.	R	~	1
3.	*Sue*; F; 1103	Thanks, Jim.	☺	+	_.	N	N	2
4.	*Leo*; M; 2379	You made it tooooooo complicated!	☹	–	_.	N	N	1
5	*Sue*; F; 1103	What is your way of solving the problem?	N	*	?	N	N	4

[a] Message number in time order. [b] Individual characteristics (IC): *nickname*, displayed gender (masculine [M], feminine [F], or no gender-identifying characteristics [N]), and the number of past posts. [c] Social cues (SC): positive SC [☺], negative SC [☹], no SC [N]. [d] Evaluation of the previous message (EPM): Agreement [+], disagreement [–], ignore/neutral [*]. [e] Invitational form (IF): statement [_.], question [?], command [!]. [f] New ideas (NI): correct, new idea [√], wrong, new idea [X], new idea with unknown validity [U], repetition [R], no mathematics content [N]. [g] Justification: justification [J], no justification [~], no mathematics content [N]. [h] Responding to which message. [i] Topic message.

Results & Discussion

The multi-level variance components model showed that the users' positive SCs and negative SCs did not differ significantly across topics, so single-level analyses at the message level were adequate. The inter-rater reliabilities as measured by Krippendorff's α for evaluation, invitational form, new ideas, and SCs were 0.89, 0.92, 0.85, and 0.93 respectively (corresponding percentages of agreement were 90%, 97%, 93%, and 96%). For both positive SCs and negative SCs, the final model's *Q*-statistics and I^2 index showed no significant serial correlation of residuals for the 60 topics up to lag 3. Thus, the time-series model was likely appropriate.

Evaluations Increase SCs

Users' evaluations were linked to more SCs in this study. Agreement (0) in the current message increased a positive SC's likelihood in the same message (+18%; when an agreement did not occur, a positive SC in the same message occurred 19% of the time; when an agreement occurred, a positive SC in the same message occurred 37% of the time; see Table 2 and Figure 1). Agreement (-1) in the previous message also increased a positive SC's likelihood in the current message (+10%). These results supported the agreement hypothesis.

Agreements in the current messages (0) and the previous messages (-1) increased the likelihood of positive SCs in the current messages (0), showing that users were likely to use positive SCs both in their own agreements and in responding to others' agreements. The results also suggest that users might distort their content via agreement to aid social relationships. Future research can test the validity of this claim.

In contrast, disagreement (0) reduced a positive SC's likelihood (–8%), supporting the disagreement hypothesis. Moreover, disagreements increased the likelihood of a negative SC (+16%). These results show that users tended not to use positive SCs to help others save face by disagreeing politely; on the contrary, they often used negative SCs to disagree rudely (face attack, Tracy & Tracy, 1998). The reduced face concern and increased psychological distance of users might have inclined them to post more offensive comments and aggressive messages. This result contrasts with that of FTF discussion studies, in which group members often disagree politely to help save face during disagreements (Brown & Levinson, 1987; Chiu, 2008a).

New Ideas Reduce SCs

Unlike evaluations, users' new ideas and justifications were linked to fewer SCs in this study. Correct new ideas, wrong new ideas, and new ideas with unknown validity reduced a negative SC's likelihood (–13%, –15%, and –9%, respectively), supporting the new idea hypothesis. A correct new idea, wrong new idea, or new idea with unknown validity in a current message reduced the likelihood of a negative SC, suggesting that users' new ideas, regardless of the type, not only provided useful information for problem solving but reduced negative SCs that might threaten their social relationships and collaboration.

Table 2: Total effects of each explanatory variable on positive SC (0), negative SC (0), and explanatory variables.

Explanatory variable (E)		Target (T)	P(T | E) (%)[a]	P(T | ~ E) (%)[b]	Effect (%)
(1)	Message number (0)	positive SC (0)	23	19	+4[c]
(2)	Initiator (0)	positive SC (0)	37	19	+18
(3)	Agreement (0)[d]	positive SC (0)	37	19	+18
(4)	Disagreement (0)[d]	positive SC (0)	11	19	–8
(5)	Justification (0)	positive SC (0)	12	19	–7
(6)	Agreement (-1)	positive SC (0)	29	19	+10
(7)	Disagreement (0)	negative SC (0)	36	20	+16
(8)	Correct new idea (0)[e]	negative SC (0)	7	20	–13
(9)	Wrong new idea (0)[e]	negative SC (0)	5	20	–15
(10)	New idea with Unknown validity (0)[e]	negative SC (0)	11	20	–9
(11)	Agreement (0)	Justification (0)	18	31	–13
(12)	Agreement (-1)	Disagreement (0)	26	44	–18

[a] Probability that the target occurs, given that the explanatory variable does occur.
[b] Probability that the target occurs, given that the explanatory variable does *not* occur.
[c] The +4% effect is explained by a 50% increase above the mean of a message's number.
[d] The baseline value for comparison is a neutral evaluation. See Kennedy (2003) for details.
[e] The baseline value for comparison is a null content or repetition message.

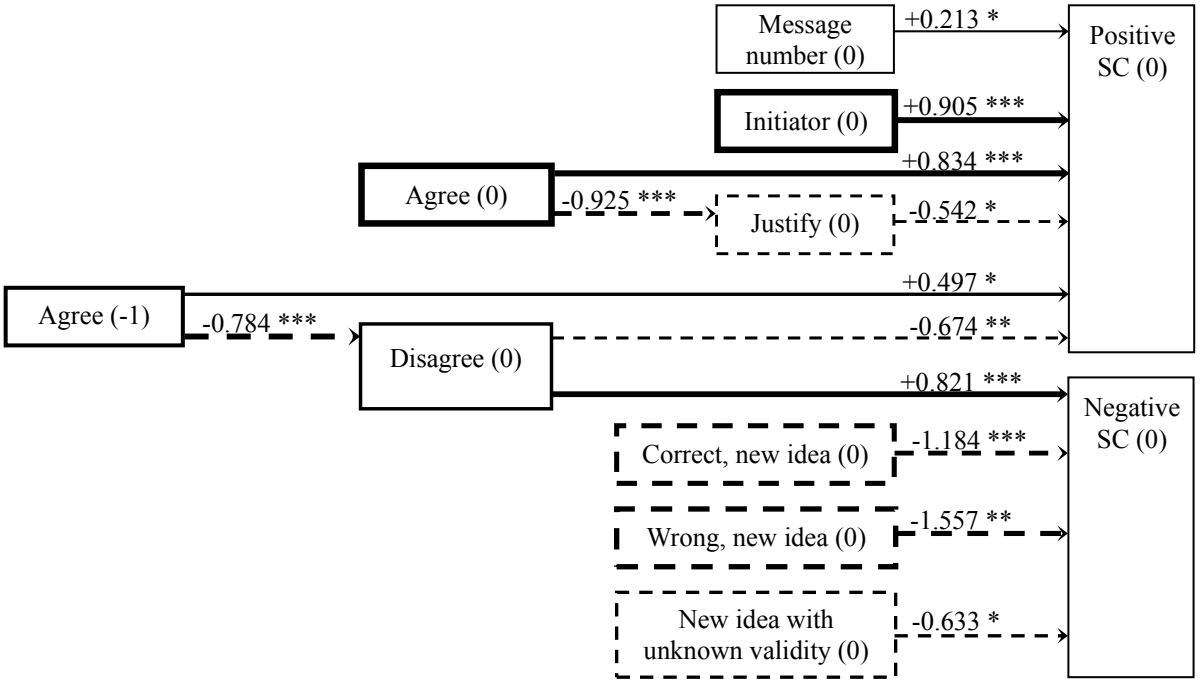

Figure 1. Path analysis of significant explanatory variables of positive SC (0) and negative SC (0) using two-level Logit. Values are standardized parameter coefficients. Solid boxes and arrows (→) indicate positive effects, dashed boxes and arrows (---) indicate negative effects, and thicker lines indicate larger effect.

Meanwhile, a justification reduced the likelihood of a positive SC (–7%), supporting the justification hypothesis. This result shows that when providing justifications that might often involve higher cognitive demands, users tended to focus more on the problem content space and used fewer positive SCs for developing social relationships. Justifications were linked to fewer SCs, supporting the claim that justifications facilitate less emotional, reason-based discussions (Chiu, 2008a).

Implications for Researchers

This study modeled conceptual relationships among online discussion messages to explore links between characteristics of recent messages with a new statistics method. These results suggest three implications for researchers involving social metacognition, public online forums, and statistical methods. First, this study highlighted social metacognition, as agreements and disagreements in the previous and current messages

influenced the likelihood of SCs in the current message. These results suggest that researchers consider how social metacognition fits into a comprehensive theoretical framework of online collaborative learning (in addition to new ideas and justifications).

Second, this study examined high school students' interactions on a public, online forum unrelated to any academic course and hence free from any course evaluation. Researchers can compare students' discussions in non-course-related forums with those in course-related forums to obtain a more comprehensive understanding of students' online behaviors. Third, this study used a new methodology for analyzing online discussion processes by modifying SDA (Chiu, 2008a; Chiu & Khoo, 2005). Moreover, we quantified the heterogeneity of the n topics by creating an I^2 index that compares the Q value with its expected value when assuming homogeneity (Huedo-Medina et al., 2006).

Implications for Teachers and Forum Designers

The results have practical implications for teachers and forum designers. The focus on content during online discussions is desirable, but disagreements were often accompanied by negative SCs in un-moderated forums. Hence, teachers can encourage students to evaluate one another's ideas carefully, thereby reducing false disagreements that might yield negative SCs. Furthermore, this suggests an important role for a teacher: fostering polite disagreements during online discussions. By doing so, students are likely to reduce rude rejections that might harm their social relationships and online collaborative learning.

As users often used negative SCs when disagreeing, forum designers can place fewer ready-to-use negative emoticons (e.g., emoticons expressing anger or attack) on the toolbar. By doing so, users are less likely to insert negative emoticons to express their impulsive negative feelings when disagreeing. (Note that users can still use positive emoticons sarcastically or to be mean, e.g., "I'm so much smarter than you ☺".)

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