Motivation and affect in peer argumentation and socio-cognitive conflict

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Abstract: Whereas the cognitive processes and effects of collaborative learning have been intensively studied within the Learning Sciences, little attention has been paid to the way motivational and emotional factors may affect them. In this symposium, we present recent findings from three independent lines of research that focus on the way motivation and affect shape the interaction between peer learners and how this, in turn, affects cognitive gains from this interaction. All three presentations focus on learning within a socio-cognitive conflict task design, while drawing on different data sources, each highlighting different aspects of the interaction process: (1) Students self-reported perceptions of the self, the other and the interaction; (2) Epistemic and motivational features of verbal dialogue content; and (3) Interactants' emotional reactions using facial signals and content-free vocal parameters of speech. The findings shed new light on how motivational and affective factors may promote or inhibit productive interactions in the face of socio-cognitive conflict.

Symposium overview

The study of peer collaborative learning has been a central theme in the Learning sciences. Considerable progress has been made in the identification of the cognitive mechanisms that enable learning in collaborative settings: For example, individual gains have been attributed to the fact that group work promotes the construction of abstract representations (Shirouzu, Miyake, & Masukawa, 2002), provides the opportunity to obtain feedback on one's own ideas (Okita & Schwartz, 2006) and primes learners to make productive use of subsequent experiences (Howe, McWilliam & Cross, 2005). In addition, studies on the quality of peer-to-peer dialogue have found that the extent to which students gain from group work depends on the depth and the quality of the dialogue they engage in (e.g., Asterhan & Schwarz, 2009a; Coleman, 1998; Webb, Troper & Fall, 1995). In spite of these advances, a considerable amount of the variance in both group productivity as well as individual learning gains remains unaccounted for. Furthermore, whereas much attention has been given to the underlying cognitive mechanisms, the study of collaborative learning has often neglected the socio-emotional aspects of these inherently social settings.

Motivation theory, on the other hand, has traditionally looked at the individual, focusing on personality characteristics, individual dispositions, and the influence of external factors on the behavior of the individual learner. For example, achievement goal theorists have extensively studied the relation between individual learning behaviors and personal goal orientations on the one hand (e.g., Butler & Neuman, 1995), or classroom goal structures on the other (e.g., Meece, Anderman & Anderman, 2006; Turner, Midgley, Meyer, Gheen, Anderman, Kang & Patrick, 2002). Until recently, the role of achievement goals in small group interaction had not been studied.

In this symposium, we aim to contribute to a rapprochement between these two lines of research, by focusing on the role of motivational and emotional aspects of collaborative learning in situations characterized by socio-cognitive conflict (Doise & Mugny, 1984). In the design of group tasks, socio-cognitive conflict is often stimulated by pairing collaborators who have different initial ideas and conceptions, by providing them with different information sources or by presenting them with data that contradicts their initial ideas. This incongruence between solutions or ideas introduces doubt concerning the correctness of one's own knowledge (Doise & Mugny, 1984), which is then hoped to cause learners to reconsider, renegotiate and/or reconstruct this knowledge through reasoned argumentation (Asterhan & Schwarz, 2007). However, when this incongruence occurs in a social realm, it may also raise uncertainty about self-competence, especially in a competitive context (Butera & Mugny, 1995). A perceived threat to self-competence may cause learners to focus more on the

relational, rather than the epistemic aspect of the conflict (Darnon, Muller, Schrager, Panuzzo & Butera, 2006). In order to avoid public exposure of lesser competence, learners may choose to comply with their co-actors and seek a quick consensus without much cognitive engagement. Conversely, they may focus on 'winning the argument' at any cost, without genuinely trying to understand any of the ideas proposed by others.

The main goal of this symposium then is to come to a better understanding of the way learners interact in and learn from collaborative learning tasks that are designed according to principles of socio-cognitive conflict. We include three independent, yet complementary lines of research that focus on the role of motivational and affective factors in these tasks. In each study, the effect of different goals is investigated, both on the way learners regulate the interaction, as well as on individual cognitive gains from these interactions. In addition, each paper investigates the interplay between the individual and the group and between the cognitive and the social, while drawing from different types of data that highlight different aspects of this interplay:

In the first paper, Fabrizio Butera and Céline Darnon review a series of studies they have conducted on the role of individual achievement goals in socio-cognitive conflict regulation. They distinguish between two types of regulation, epistemic and relational, and show that the goals that students pursue direct their attention towards different aspects of the interaction, leading to different outcomes.

In the second paper, Christa Asterhan, Baruch Schwarz and Ruth Butler focus on peer-to-peer argumentation as a vehicle for learning and understanding complex scientific concepts. They distinguish between argumentation as an activity of competitive debating and argumentation as a space in which learners can critically, yet constructively examine different ideas. They examine how these different types of dialectical argumentation can be elicited and measured, and what their relationship is to conceptual learning.

In the third paper, Timothy Nokes, John Levine, Dan Belenky and Soniya Gadgil report on a study that examines the relationship between different debate scenarios and individual learning outcomes. To get insight into the underlying cognitive and social processes that mediate these effects, they focus both on epistemic content of the interaction, as well as measures of student engagement and affect including, among others, behavioral indices and content-free vocal parameters of speech.

Socio-cognitive conflict and learning: past and present.

Fabrizio Butera & Céline Darnon

In the present talk, we contend that dissent with others' points of view should be a customary and promoted activity whenever learning is concerned. Indeed, dissent occurring during group or peer learning favours cognitive development and knowledge acquisition. We present a theory of socio-cognitive conflict, which argues that dissent with one or several partners over a task in which learning is concerned may stimulate task-related cognitive activity and result in progress (Doise & Mugny, 1984). Should, therefore, socio-cognitive conflict be prescribed in educational settings? We address this question by drawing on research in which we found that socio-cognitive conflict is beneficial for learning to the extent that conflict is regulated in an epistemic manner, that is, by focusing on the task or on the knowledge at hand. On the contrary, socio-cognitive conflict can result in detrimental effects whenever conflict is regulated in a relational manner, that is by focusing on status and on interpersonal dominance (Darnon, Buchs, & Butera, 2002). A recent experiment illustrates these dynamics (Darnon, Doll, & Butera, 2007). University students participated in a fictitious computer-mediated interaction about a text with a bogus partner who introduced through her/his rhetoric either an epistemic conflict (a conflict that referred to the content of the text), or a relational conflict (a conflict that questioned participants' competence). Results indicated that compared to the epistemic conflict, the relational conflict enhanced threat and reduced the perceived contribution of the partner. Moreover, when the conflict was epistemic, the stronger the perceived conflict, the more participants said they worked through the problem to understand it better and tried to integrate the two points of views, that is, the more they regulated the conflict in an epistemic way. On the contrary, after a relational conflict, the stronger the perceived conflict, the more participants said they tried to assert they were right and the other person was wrong, that is, the more they engaged in a relational regulation of the conflict. Finally, epistemic conflict elicited better learning than relational conflict.

This distinction is of importance with respect to the question of the usability of socio-cognitive conflict, as recent research has shown that the two forms of conflict regulation are predicted by different achievement goals, goals that can be implemented in the classroom (Meece, Anderman, & Anderman, 2006). Indeed, we have found that epistemic regulation is predicted by mastery goals (the will to acquire knowledge and develop competences), and relational regulation is predicted by

performance goals (the will to demonstrate competence relative to others; Darnon et al, 2006). In this study, French introductory psychology students – for whom mastery and performance self-set goals had been recorded – were asked to imagine a discussion with another person who disagreed with them about an experiment they had studied in class during the previous semester. They were then asked to report to what extent during this "debate" they would try to regulate the conflict in an epistemic way or a relational way. Items related to epistemic regulation asked students to what extent when disagreements occurred they would try (a) to think about the text again in order to understand better, (b) to examine the conditions under which each point of view could help them understand, and (c) to think of a solution that could integrate both points of view. Items related to relational regulation asked students to what extent when disagreements occurred they would try (a) to show they were right, (b) to resist by maintaining their initial position, and (c) to show their partner was wrong. Results indicated that mastery goals positively predicted the reported amount of epistemic conflict regulation whereas performance goals positively predicted the reported amount of relational conflict regulation.

Importantly, we have also found that achievement goals interact with socio-cognitive conflict to predict actual learning (Darnon, Butera, & Harackiewicz, 2007). In this study, participants were led to think they interacted with a partner via a computer sharing opinions about a text that they were studying. Mastery and performance goals were manipulated. During the "interaction", they received either disagreeing or agreeing answers from this bogus partner. Results showed that the condition in which mastery goals were induced led to better learning than the performance goal condition only when the partner disagreed. No differences between goal conditions were observed when the partner agreed. In other words, when conflict is elicited during interaction, mastery goals have the potential to make conflict constructive, and lead to better learning than performance goals.

Notwithstanding the positive effects of mastery goals, in a further line of research we have discussed the problem that education takes place in organisations that are concerned with formation *and* selection. Because of this very functioning, a profound ambivalence is embedded in achievement goal promotion in universities (Darnon, Dompnier, Delmas, Pulfrey, & Butera, 2009). Mastery goals promotion is recommended by most researchers, and promoted in the discourse of most teachers. Thus, the student who strongly endorses mastery goals fulfils the teachers' motivations and aims and is consequently perceived as someone who is appreciated by teachers. This is not the case for performance goals, which are not valued by teachers in their discourse. However, the selection processes through which the students have to go in their university career implicitly indicate that, in order to succeed, they not only have to improve knowledge but also get better grades than other students. Thus, not only mastery goals but also performance goals are seen by students as effective tools to succeed at university (see also Dompnier, Darnon, Delmas, & Butera, 2008). In sum, it appears that students are aware of the two functions of university, namely education (apparent in teachers' official discourse) and selection (hidden in the university structure). This means that self-presentation concerns may interfere with mastery goals in shaping the students' social interactions and academic achievement.

The finding that students are aware of this double function of educational organisations, at least as far as university is concerned, may shed light on puzzling but consistent result that mastery goals positively impact achievement-related outcomes, but paradoxically hold an inconsistent relation with academic achievement. Dompnier, Darnon and Butera (2009) hypothesized that this relationship depends on why students endorse mastery goals—namely, to garner teachers' appreciation (social desirability) or to succeed at university (social utility). First-year psychology students completed a mastery goal scale in a standard format, with social desirability instructions and social utility instructions. Participants' grades on academic exams were recorded later in the semester. Results indicated that students' perceptions of both social desirability and social utility related to mastery goals moderated the relationship between mastery goal endorsement and final grades. The less participants perceived these goals as socially desirable, the more the goals predicted grades. Conversely, the greater their perceived social utility, the higher their predictive value. In other words, mastery goals appear to be related to learning to the extent that students do not endorse it for self-presentation reasons (Dompnier, Darnon, & Butera, 2009). We conclude this talk by reflecting upon the goals promoted by educational organisations that may favour or hinder the constructive effects for learning of socio-cognitive conflict.

On competitive and co-constructive dialectical argumentation

Christa S. C. Asterhan, Baruch B. Schwarz and Ruth Butler

Recent research seems to indicate that simply designing tasks according to principles of socio-cognitive conflict may often not be sufficient for students to capitalize on the affordances that are

created in such task designs, and that this may be particularly true for learning that involves conceptual change: In two separate experimental studies, students who were instructed to engage in dialectical argumentation on the topic of natural selection gained from interaction with an equal-status peer, whereas students that were not instructed to do so did not (Asterhan & Schwarz, 2007). Moreover, a follow-up study showed that conceptual gains were dependent on the extent to which students engaged in argumentation moves that are characterized by a dialectical and critical stance towards proposed explanations (Asterhan & Schwarz, 2009a).

However, further in-depth analyses of selected dialogue protocols seemed to indicate that not all forms of dialectical argumentation may have the same beneficial outcomes (Asterhan, 2007): Learners did not seem to gain when the dialogue was characterized by an adversarial, debate-like atmosphere. The dialectical argumentation of gaining dyads, on the other hand, was characterized by a particularly pleasant and constructive, yet critical atmosphere. These dyads used several sophisticated techniques (such as, for example, spontaneous role-playing and posing "What if.." scenarios) to preserve the delicate balance between critically examining each others' ideas while maintaining a pleasant and supportive atmosphere. Moreover, the episodes of critical examination were interspersed with episodes of collaborative construction of explanations. We therefore called this type of dialogue *co-constructive, dialectical argumentation* (Asterhan & Schwarz, 2009b). In the present presentation, we aim to explore the following questions: (1) How can this particular type of peer dialogue be elicited; (2) Can co-constructive, dialectical argumentation be reliably and quantitatively distinguished from adversarial argumentation; and (3) Do these different types of peer dialogue lead to differences in learning and understanding conceptual content?

In a recent series of studies Darnon, Butera and colleagues investigated the role of motivational differences of individual learners' achievement goal orientations in academic situations characterized by socio-cognitive conflict (e.g., Darnon et al, 2002, 2006, 2007). These studies showed that both existing as well as manipulated differences in achievement goals can predict learning from short computer-mediated communication with a fictitious, disagreeing partner: Whereas mastery goals (a focus on learning and personal improvement) positively related with learning, performance goals (a focus on individual ability comparisons) did not. We sought to extend this research to the domain of peer argumentation and learning that involves conceptual change. Unlike in the settings investigated by Darnon, Butera and colleagues, in learning tasks that target particularly difficult scientific concepts students are often uncertain of the correctness of their prior knowledge and their ability to perform well.

In a first study, we focused on the relation between students' individual achievement goal orientations and four different types of self-reported collaborative behavior (Asterhan, Schwarz & Butler, 2009). Undergraduates were situated within an educational setting in which they were asked to solve and reveal their knowledge concerning an ill-structured, complex astronomy-related topic. They were then asked questions concerning their behavior in a peer collaboration setting in which they were to discuss their solution with a disagreeing peer. Four different categories of self-reported peer collaboration behavior were assessed: Quick consensus seeking, adversarial argumentation, co-constructive dialectical argumentation and private dialectical deliberation. The results showed, among others, that mastery orientations predicted co-constructive dialectical argumentation, whereas performance-approach goals predicted adversarial argumentation. These findings encouraged us to further explore the relation between goals, argumentation and conceptual learning in an experimental set-up. In addition, since certain patterns of peer collaboration behavior are believed to mediate the relation between achievement goals and learning from socio-cognitive conflict, the verbal interactions were analyzed with the help of a coding scheme that aimed to distinguish between adversarial and co-constructive dialectical argumentation.

A description of the study

Forty-two undergraduates (22 female, 20 male) without any prior formal education on the topic of natural selection participated in this study. The general procedure and materials were based on and adapted from Asterhan and Schwarz (2007). All students participated in the following sequence of activities: 1) Individual pretest to assess prior evolutionary understanding; (2) Instructional intervention: screening of a 20 *min* instructional movie excerpt on natural selection; (3) Experimental intervention: Students were randomly paired in same-sex dyads and instructed to engage in un-scripted, computer-mediated peer argumentation on two novel transfer items, according to two different sets of goal instructions; (4) Delayed post-test administered a week later. The pre- and delayed post-test contained equivalent items on different evolutionary phenomena. Following the movie, each participant communicated with one peer alias, which was predefined in the instant messaging environment (Yahoo! chat). All students received instructions to try and solve a particular transfer item themselves

and then engage in 'a critical discussion' on their explanations of the phenomena. Half of the dyads were told that the goal of a critical discussion is to persuade the other to adopt one's own explanation (emphasizing it as an interpersonal competition and a win-loose situation), and half of the dyads were told that the goal is to gain a better understanding through discussion (emphasizing the importance of co-constructive, yet dialectical argumentation). They were given several examples of different dialogue moves, appropriate to each condition. Individual evolutionary understanding was assessed in terms of (a) the mean quality of the explanatory schemas students used, and (b) the mean number of correct Darwinian principles that students explicitly mentioned in their written explanations of different evolutionary phenomena.

Two complementary, independent coding schemes were developed to analyze the computer-mediated dialogue protocols. Both used turns as the unit of analysis and both were non-exhaustive: The first distinguished between different *epistemic activities* (de Vries et al, 2002; Ohlsson, 1995) students engaged in when trying to understand the concept of natural selection. Only on-task dialogue content was coded. Based on distinctions proposed by Asterhan and Schwarz (2009) it mainly distinguished two categories of epistemic dialogue moves: those that reflect consensual construction and validation of explanations (including, among other, elaborations, justifications and agreements; hereafter referred to as CCVE) and those that reflect critical-dialectical argumentation (including, among others, counterarguments, rebuttals, challenges, critical questions and oppositions; hereafter referred to as CDA).

The aim of the second coding scheme was to assess the extent to which the verbal dialogue contained overt markers that indicated the endorsement of a competitive interpersonal goal or the endorsement of a collaborative interpersonal goal. It was applied to all dialogue turns. The scheme was inspired by distinctions proposed by Chiu and Khoo (2003) and included the following: Competitive markers included verbal content that overtly emphasized the interpersonal conflict between persons instead of solutions (e.g., "*You* say that X whereas *I* claim that Y"), increase face threat (e.g., explicitly stating that the other is wrong) and/or relate to the inferiority of the partner's abilities or explanations (e.g., using sarcasm when evaluating an explanation proposed by partner). Collaboration markers included overt verbal content that aimed at decreasing face threat when a conflict arises (e.g., using smileys and other positive emoticons, or framing disagreements in a neutral, non-personal way), emphasizing a common goal and shared responsibility (e.g., "We should find the right explanation") and/or decreasing interpersonal competitiveness and potential differences in competence (e.g., hedging explanations and complimenting partner).

Main findings and discussion

No significant differences in conceptual gains were found between the two condition (framing dialectical argumentation as a mechanism for learning or as a competitive activity). However, for both measures of conceptual understanding an interaction effect was found for condition and gender, such that female students significantly outperformed male students in the competitive framing condition, but not in the 'argumentation for learning' condition. The overall pattern showed that female students fared better when dialectical argumentation was framed as a competitive rather than as a co-constructive activity, whereas for male students the competitive framing was detrimental for learning (no gains) and the co-constructive framing resulted in moderate learning gains. The dialogue analyses shed some light on these surprising findings. In spite of the *competitive* framing, the female dialogues in this condition were actually characterized by co-constructive dialectical argumentation: They included a high number of both CDA as well as CCVE dialogue moves. Moreover, whereas the dialogues included a relatively high number of competitive dialogue markers, this was compensated for by an even larger number of collaborative markers. The male dialogues in this condition, on the other hand, were characterized by adversarial dialectical argumentation (a high number of CDA and competitive markers and virtually no collaborative markers).

Even though it is difficult to generalize from this first study, the data seem to support the claim that co-constructive dialectical argumentation fosters the learning of complex concepts, whereas adversarial argumentation does not. However, it is also clear that either form of peer-to-peer dialogue is not easily elicited and that goal instructions may have different effects for different types of learners (e.g., male and female). Moreover, manipulated goals seem to have a lesser effect in prolonged activities that more closely resemble actual collaborative learning settings. The implications of these findings for theory and future research will be discussed in the presentation.

Investigating the Impact of Dialectical Interaction on Engagement, Affect, and Robust Learning

Timothy J. Nokes, John M. Levine, Dan Belenky, and Soniya Gadgil

Our work lies at the intersection of motivation, affect, social interaction, and learning. We are interested in how dialectical interaction impacts conceptual learning vis-à-vis motivation and affect. In this research, we focus on situations in which two or more people with roughly equal status but alternative viewpoints either compete with one another or work together to accomplish some goal or task, such as winning a debate or achieving consensus on a controversial issue. In this symposium, we will report some of our initial work examining the impact of various types of debate scenarios on students' conceptual learning, engagement, and affect.

This work builds on prior research investigating the relationship between cognitive conflict and learning (e.g., Doise & Mugny, 1984), the links between motivation, affect, and cognition (e.g., Forgas, 2001; Schwarz & Clore, 2007), and the mechanisms underlying conceptual learning (e.g., Chi & Ohlsson, 2005; Nokes & Ross, 2007). Although much prior work has investigated each of these areas separately, few studies have tried to build connections across all three. We hypothesize that conflict scenarios that increase engagement, arousal, and positive affect will facilitate participants' deep processing of discourse through a variety of cognitive mechanisms including inference generation, elaboration, analogy, and the framing and re-framing of the information discussed. Participants in such scenarios are expected to develop more complex and coherent knowledge of the issue and to learn both their own and their opponent's side of the issue. In contrast, conflict scenarios that decrease engagement, arousal, and induce negative affect should lead to less robust learning. Participants in these scenarios are expected to focus on their own side of the debate, ignoring their opponent's view, and to engage in shallow cognitive processing strategies such as rehearsal of their own argument.

These hypotheses are consistent with prior research on collaboration showing that when participants are more engaged in performing a task (as measured, for example, by their elaborations of a peer's contributions) they show larger learning gains than do those who are less engaged (Meade, Nokes, & Morrow, 2009). Similar findings have been shown in human tutoring (e.g., Chi, 2009) and learning from intelligent tutoring systems (e.g., Baker, Corbett, Koedinger, & Wagner, 2004). In addition, research has shown that participants in a positive mood are more likely to rely on prior knowledge and assimilate new knowledge into that understanding, whereas participants in a negative mood show more bottom-up processing and less integration (e.g., Forgas, 2008). We aim to extend these lines of research by examining the relationships that emerge between learning, engagement, and affect under different debate scenarios.

Study Description

To investigate these general hypotheses, we are conducting a study in which we manipulate two aspects of a debate: the *format* (open-ended versus alternating) and the *performance criterion* on which participants are evaluated (substance versus style of their arguments). We expect participants in the open-ended condition to learn more and to show higher task engagement and arousal than those in the alternating condition. Further, we predict that, compared to participants evaluated on the style of their arguments, those evaluated on substance will learn more, will be more engaged, will show more positive affect, will engage in deeper cognitive processing (inference generation, explanation, framing, etc.), and will pay more attention to the logic, coherence, and consistency of their argument as well as their opponent's argument. In addition, we predict an interaction between our two independent variables, such that the participants in the style condition will benefit more from the open-ended debate format than will participants in the substance condition. This prediction is based on the assumption that participants evaluated on substance will focus on the content of their opponent's arguments regardless of the format of their debate, whereas participants evaluated on style will process more of their opponent's argument in the open-ended than in the alternating condition.

Fifty-two undergraduates at the University of Pittsburgh have so far participated in the experiment for course credit (total sample will be 160). The study uses a 2 (debate format: open-ended vs. alternating) X 2 (performance criterion: substance versus style) between-subjects design with participants randomly assigned to one of the four conditions. Participants are run in dyads, and the experiment is composed of three parts: a study phase, a debate phase, and a test phase. There are two study booklets, one for each participant in the dyad. Both booklets have the same 1-page introduction to the topic (the "Fall of the Ottoman Empire") and description of the historical significance of the issue, along with a map of the Middle East. This is followed by two pages of text containing arguments for either external or internal causes for the fall of the empire. The test booklet consists of a 26-question multiple-choice test assessing information contained in the study booklets and an open-ended essay question in which participants describe the reasons for the fall of the Ottoman empire. Next, participants complete the 'Need for Cognitive Closure' scale (Kruglanski, Webster, & Klem, 1993).

Within each dyad, one participant is randomly assigned to the external causes condition and the other to the internal causes condition. After studying the materials for their side of the issue for 15 minutes, participants are given instructions for the debate. In the "substance" condition, participants are told they will be evaluated on the substance and the logic of their argument. In the "style" condition, they are told they will be evaluated on the style of their arguments. All participants are told that their goal is to win the debate. In the "open-ended" condition, participants engage in an 8-minute free-form debate. In the "alternating" condition, participants speak for eight alternating one-minute turns (four/participant), which are timed by the experimenter. Immediately afterwards, participants are given a brief questionnaire, assessing their subjective experiences and feelings in the debate. The winner (as assessed by the experimenter) is then awarded a small prize, and participants are debriefed and thanked for their participation.

During the debate, participants are audio and video taped for later behavioral coding of their arguments, task engagement, and affect. For example, we will analyze participants' verbal protocols to determine instances of inference generation, explanation, elaboration, analogy making, and framing. Moreover, we will assess participants' task engagement and affect by coding selected vocal qualities of their speech (Fussell, 2002; Justin & Scherer, 2005).

Preliminary Results and Future Analyses

Preliminary results (based on one-third of our planned sample) suggest that, on the multiple-choice test, participants in the substance condition are learning more than those in the style condition. In addition, participants are performing better on questions that assess their side of the argument than their opponent's side. Finally, participants in the substance conditions are performing better than those in the style condition in learning *both* their own and their opponent's argument. So far, we are not seeing a clear trend in the findings regarding debate format.

In the symposium, we will discuss results from the full sample and will report findings from the full range of dependent measures that we are obtaining. We will provide an in-depth analysis of student engagement and affect based on both questionnaire measures and behavioral indices. We will also analyze the content of the debates to gain insight into the underlying cognitive and social processes that mediate the learning outcomes. We will conclude our presentation by discussing implications of our work for instruction and pedagogy.

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