Inhibitors and Facilitators of Peer Argumentation that Supports Conceptual Learning: The Role of Achievement Goals

Christa S. C. Asterhan, Baruch B. Schwarz & Ruth Butler
(christa.asterhan@mail.huji.ac.il, msschwar@mscc.huji.ac.il, msbutler@mscc.huji.ac.il)
School of Education, Hebrew University of Jerusalem, Mt. Scopus
Jerusalem 91905, Israel.

Abstract

Recent research suggests that peer-to-peer argumentation supports conceptual change in students' knowledge structures in science and mathematics, provided that students actually juxtapose and evaluate different ideas in a critical, yet co-constructive manner. However, it is well known that this type of peer-to-peer dialogue is not easily elicited and sustained, especially on scientific topics. In this paper, we report on findings from research that investigates how the pursuing of different goals may result in more or less productive types of peer interaction and peer argumentation, and how this, in turn affects conceptual learning from these interactions. In study 1, we focused on the relation between students' individual achievement goal orientations and four different types of peer interaction behavior, with the help of self-report questionnaires. In study 2, the effect of different interaction goal instructions (co-constructive vs. competitive) is tested on peer dialogue and on subsequent individual learning gains.

Keywords: argumentation, dialogue, conceptual change, peer interaction, achievement goal orientations.

The term "conceptual change" refers to a specific form of learning that requires the transformation of misconceived, intuitive knowledge to correct scientific knowledge (Chi, 2008). The literature has extensively shown that many misconceptions are often very adaptive in everyday life, compatible with everyday experience and sustained by ambiguous language use. These misconceptions are, therefore, difficult to uproot even with traditional show-and-tell teaching techniques. So as to induce conceptual change, specifically designed learning activities are required, many of which are based on the Piagetian notion of creating cognitive conflict (Piaget, 1985). However, several recent studies have shown that merely confronting students with contradictory data or pairing them with a disagreeing peer is not sufficient by itself and that engagement in peer argumentation is an important condition for achieving conceptual gains within such settings (Asterhan & Schwarz, 2007; Nussbaum & Sinatra, 2003; Schwarz, Neuman & Biezuner, 2000). Recent findings from detailed peer-to-peer protocols show that it is the dialectical, critical consideration of different ideas that produces substantive conceptual gains (Asterhan & Schwarz, 2009a). Consensual moves of explanation and elaboration, on the other hand, were not found to predict conceptual change following peer dialogue. Thus, students should actively and explicitly confront and criticize different explanations to gain from peer dialogue.

However, it is well known that such dialectical peer-to-peer argumentation is not easily elicited when it comes to discussing scientific topics (e.g., deVries, Lund & Baker, 2001; Hausmann, 2005; Nonnon, 1995). Moreover, in-depth analyses of student dialogues have also shown that competitive, debate-like dialecticism was not followed by conceptual change. The dialectical argumentation of gaining dyads, on the other hand, was characterized by a pleasant and constructive, yet critical atmosphere (*co-constructive critical argumentation*) (Asterhan & Schwarz, 2009b). Although not identical, these distinctions are reminiscent of Doise and Mugny's (1984) distinction between *epistemically* vs. *relationally* regulated socio-cognitive conflict.

Even though individual cognitive skills definitely play a role in peer argumentation (Kuhn, 1991; Means & Voss, 1996), these findings strongly suggest that we should not only confine the study of argumentation and of learning from peer argumentation to the realm of cognitive skills. In addition, we should also consider the role of psychosocial factors as inhibitors or facilitators of the type of peer dialogue that may support or suppress learning within socio-cognitive conflict settings. Previous research has focused on the role of an individual's need for cognition, epistemological beliefs and extraverted personality traits on their willingness to engage in argumentation (Nussbaum 7 Bendixen, 2003). In this paper, we focus on achievement goal orientations (e.g., Ames & Archer, 1988; Butler, 2000), that is: the goals students pursue when they perform an achievement task, and their relation with different types of peer dialogue when these are required to engage in a critical discussion on a learning topic.

In spite of the extensive literature on achievement goals, its role in peer collaboration has been largely unexplored. Some first attempts have been undertaken by social psychologists: For example, Levy, Kaplan and Patrick (2004) have explored the relations between achievement goals, social status and students' preferences and willingness to cooperate with peers from different social groups. In a recent set of experimental studies by Darnon and colleagues (Darnon, Buchs & Butera, 2002; Darnon, Muller, Schrager, Panuzzo, & Butera, 2006; Darnon, Butera & Harackiewicz, 2007) individual learners were confronted with a fictitious partner that proposed a different solution from theirs. It was shown that achievement goals predicted learning gains from short computer-mediated communication with this fictitious partner: Whereas mastery goals (a focus on learning and personal improvement) positively related with learning gains, ability goals (a focus on individual ability

comparisons) did not. Thus far, however, these effects have yet to be tested within settings that target learning that involves conceptual change. Moreover, peer collaboration behavior was not directly assessed in these studies, even though it is believed to mediate the effect of goal orientations on learning gains from socio-cognitive conflict. Finally, Darnon and colleagues did not distinguish between the two different types of ability goals that have been observed in the motivation literature: Ability-approach goals, that orient towards showing one's competence and superior performance, and ability-avoidance goals, that orient towards avoidance of showing low performance and receiving negative judgments (Elliott & Church, 1997; Elliott & Harackiewicz, 1996). These two types of ability goal have been shown to lead to distinctively different learning behaviors in individual learning settings (e.g., Elliot & Church, 1997).

Research questions

In the present study we aim to investigate the relation between achievement goal orientations and peer collaboration behaviors in socio-cognitive task settings that have been suggested to inhibit or to foster conceptual change. Since mastery involvement orients towards improving understanding and preference for challenging tasks (see for example Butler, 2000, for an overview) it is expected to be positively related with behavioral measures of co-constructive, critical argumentation. Ability goals that orient students to strive to demonstrate superior ability (ability-approach), on the other hand, are expected to be positively related with measures of competitive debating, whereas ability goals that orient students to mask inferior ability (ability-avoidance) will lead students to engage in behaviors that aim at reaching quick agreement without genuine deliberation.

As a first step in our overall research endeavor, these hypotheses are tested with self-reported measures of peer collaboration behaviors in simulated interaction settings (Study 1). The findings from this first study are then used to test the effect of different goal instructions on peer interaction behavior and on subsequent conceptual change in actual learning settings (Study 2).

Study 1

Method

Participants. One hundred and eighty six students from the Education (39%), Humanities (8%), Social Sciences (47%), Law (3%) or other (3%) faculties participated in this study (22% male, 78% female). Average age of participants was 24.47 (*SD* = 3.97), 170 students (91%) were of Jewish and 16 (9%) of Arab origin. Over half of the students (56%) received course credit; others (44%) chose to be financially reimbursed. Two participants failed to fill out one of the questionnaires and their data was therefore included only in the questionnaire validation procedures.

Procedure. Students were informed that the goal of the research was to study different aspects of student learning and discussion practices. They were then asked to fill out two questionnaires. Order of presentation was counterbalanced. In one questionnaire (the achievement goal orientations questionnaire, students were asked to report on their feelings and thoughts at the start of a new course as part of their Major studies by responding to a pre-defined set of test items. The other questionnaire, termed the Peer Collaboration Behavior in Socio-cognitive Conflict (PCBSC) questionnaire, included two sections: In the first part, students were instructed to answer a question that refers to the phenomena of day and night and to celestial bodies. They were shown a picture of the earth which was taken by a robot stationed on the moon (see Figure 1). Students were then asked to indicate whether it was dark of light on the moon location from which the picture was taken. They were forced to choose one of the following four responses and elaborate their choice: (a) It is light; (b) It is dark; (c) There are no light and dark differences on the moon; (d) One cannot know. This question was chosen because students are not ignorant on astronomical events and are capable to reason on the topic, whereas on the other hand they are likely to have merely intuitive or partial knowledge. Moreover, the question was complex enough to leave room for doubt and for students to realize that they could learn from another peer and from peer discussion. After indicating their reasoned and elaborated answers, they read the following instructions (part 2 of the PCBSC questionnaire):

> Try to imagine yourself in the following situation: You participate in a small-size course and your lecturer instructs each student to individually solve the Moon question. After 5 min of individual work the lecturer assigns the students to dyads and instructs each dyad to discuss their solutions to the Moon question. When the student you are assigned to presents his/her solution, it appears that you disagree on what should be the correct solution (i.e., he/she chose a different answer). How would you behave in such a situation?

Figure 1. "Is it dark or light on the moon location from which this picture of the earth is taken?"

Students were then asked to report on their peer collaboration behavior in this situation of socio-cognitive conflict, by indicating the extent to which each of 16 different behaviors characterize them in this interaction. The behavioral categories assessed were: Co-constructive dialecticism, Private dialectical deliberation, Competitive debating and Quick consensus seeking.

Measures. *Achievement goals*. Individual achievement goal orientations were assessed with 18 items extracted from Church and Elliott's (1997) scale, translated to Hebrew and validated by Kogut (2002). There were six mastery goal items (e.g., "I hope that after the course I will have a better and deeper understanding of the topics we learned"), six ability-approach goal items (e.g., "It is important for me to perform better than the other students in this course") and six ability-avoidance goal items (e.g., "I just want to avoid failing the course").

Perceived domain knowledge and confidence. Students rated their confidence in the correctness of their respective explanation to the moon question, on a scale ranging from 1 (not at all confident) to 4 (very confident). Perceived domain knowledge was assessed by one item ("How do you evaluate your knowledge on astronomical topics, such as the day/night cycle, the phases of the moon, seasonal changes, celestial bodies, and so on?"). The scale ranged from 1 (none) to 5 (very high).

Peer collaboration behavior in socio-cognitive conflict (PCBSC). Students were asked to report to what extent (on a scale ranging from 1 = not at all to 7 = exactly) each item would describe their behavior in the simulated situation of discussing a scientific topic with a disagreeing peer. Fifteen items were created based on the literature on peer dialogue that supports conceptual change (see Table 1). Four items each were created for three different behavioral categories: *Co-constructive, critical peer argumentation* (items 1-4), *Competitive debating* (items 5-8), and *Quick consensus seeking* (items 9-12). A fourth type of behavior was defined, *Private critical deliberation*, which refers to the critical consideration of different perspectives in a private, non-dialogical manner (items 13-15).

Table 1. PCBSC items and their factorial loading via principal-component extraction with varimax rotation*

	Item	Factor 1	Factor 2	Factor 3	Factor 4
1.	I try to understand why my partner believes my answer is wrong	.744			
2.	I try to collaboratively examine each idea critically with my partner	.758			
3.	I try to have my partner explain his/her ideas to me more precisely	.774			
4.	try to think together what could be the best answer	.888			
5.	I try to defend my own explanation at any price		.790		
6.	I try to show my partner why s/he is wrong		.749		
7.	I try to prove him/her that I am right		.814		
8.	I try to hold on to my own initial standpoint		.713		
9.	I try to avoid any confrontation between myself and my partner			.765	
10.	I prefer to concede and terminate the discussion quickly			.720	
11.	I prefer that the other will lead the discussion and develop his/her solution			.690	
12.	I try to reach an agreement as fast as possible		.513	.600	
13.	I re-examine my ideas independently and by myself				.589
14.	I try to consider the differences between the answers by myself				.822
15.	I prefer to re-think my solution independently before my next move				.795

* Factorial loadings below .30 are suppressed.

Results

Factorial structure of the PCBSC scales. Factor analyses were conducted on the 15 peer collaboration behaviour items via principal-components extraction with varimax rotation. The results of these analyses are presented in Table 1 and yielded four factors: Factor 1 comprised the four items of co-constructive, critical argumentation and accounted for 19.2% of the variance. Factor 2 comprised the four competitive debating items and item 12 ("reach a quick agreement") and accounted for an additional 18.8% of the variance. Factor 3 comprised the four quick consensus seeking items and accounted for an additional 13.9%. Finally, factor 4 comprised the three private critical deliberation items and accounted for an additional 12.7%. Together, the four factors accounted for a total of 64.6% of the variance. Scale reliabilities of the different variables are present in Table 2.

Overall, the PCBSC scales enabled the identification of four distinctively different and reliable behavioral categories for regulating socio-cognitive conflict.

Predicting conflict regulation with achievement goals For each of the four behavioral categories we conducted two-step hierarchical regression analyses: The first model included the three different types of achievement goals, mastery, performance-approach and performance-avoidance. In step 2, two predictors were added to the first model: Confidence in correctness of one's explanation and perceived domain knowledge. Results from the regression analyses are summarized in Table 3.

Co-constructive critical argumentation: As expected, mastery goals significantly predicted self-reported engagement in co-constructive critical argumentation with a peer. Neither one of the two ability goals, nor the measures of confidence and domain knowledge significantly added to this prediction. It should be noted, however, that the standardized regression parameter for ability-avoidance goals reached marginal significance (t (175) = 1.88, p = .062). The total model accounted for 18% of the amount of variance.

Competitive debating. Of the different achievement goals, both ability-approach and mastery goals predicted the extent to which students reported to engage in behavioral measures of competitive debating. When the two additional variables were entered into the regression equation, however, only students' ability-approach goals and their self-reported confidence in the correctness of their explanation significantly predicted competitive debating, accounting for a total of 19% of the variance.

Table 2. Descriptive statistics and reliability of the different variables

Variable	M	SD	α
Mastery goals	5.47	1.09	.85
Ability-approach goals	4.35	1.39	.89
Ability-avoidance goals	4.18	1.10	.67
Co-constructive, critical argumentation	5.37	1.10	.82
Competitive debating	3.54	1.27	.82
Quick consensus-seeking	3.28	1.13	.65
Private deliberation	4.42	1.22	.67

Quick consensus seeking. As expected, ability-avoidance goals significantly predicted quick consensus seeking. In addition, mastery goals were negatively related with this behavioral measure. The standardized parameter for mastery goals was marginally significant in the first model (p = .054) and reached significance in the second model (p = .038). None of the other variables added to the prediction of quick consensus seeking. The two models accounted for 9% and 7% of the total amount of variance, respectively.

Table 3. Results from hierarchical regressions analyses for predicting the four different types of peer collaboration behavior in socio-cognitive conflict (N = 184)

	Co-constructive critical argumentation		Competitive debating		Quick consensus seeking		Private critical deliberation	
	β^a	β^b	β^a	β^b	β^a	β^b	β^a	β^b
Step 1								
Mastery goals	.39***	.40***	.17*	.13	-.14	-.16*	.27***	.23**
Ability-approach goals	-.03	-.04	.23**	.24**	.07	.07	.14	.14
Ability-avoidance goals	.14	.13	-.02	-.01	.25**	.24**	-.02	-.02
Step 2								
Confidence		-.11		.24**		-.06		-.05
Perceived domain knowledge		.02		.12		.10		.20*
R^2	.17***	.18***	.10***	.19***	.09***	.07***	.11***	.14***
ΔR^2		.01		.10***		.01		.03*

[a] For models including variables in step 1. [b] For models including all five variables.
* p < .05, ** p < .01, *** p < .001

Private critical deliberation. The first model accounted for 11% of the total amount of variance, with mastery goals significantly adding to the prediction of private deliberation, and ability-approach reaching marginal significance (p = .066). In the second model, the addition of the two additional variables improved the predictive power of the regression equation to some extent (ΔR^2 = .03). Both students' mastery goals and their perceived domain knowledge were found to significantly predict the extent to which students reported to engage in critical , but private deliberation.

Discussion

Based on the literature, we discerned between four different types of behavioral patterns to regulate socio-cognitive conflict in learning settings. The results in this study showed first of all that these different patterns can be distinctively and reliably assessed with the help of self-report questionnaires.

Secondly, they also showed that students' achievement goals predict different behavioral patterns of socio-cognitive conflict regulation in learning settings. As expected, mastery goals -but not ability goals- predicted co-constructive critical peer argumentation and ability-avoidance goals predicted quick consensus seeking. Competitive debating, on the other hand, was predicted by ability-approach goals and by students' confidence in the correctness of their explanation. Finally, mastery goals and domain knowledge predicted private critical deliberation.

The PCBSC scales assess individual dispositions for different patterns of socio-cognitive conflict regulation in learning settings. Previous studies have provided first indications that one of these patterns, namely co-constructive critical argumentation, is particularly productive for conceptual learning and conceptual change, whereas others, namely competitive debating and quick consensus-seeking, may be detrimental. However, the effects of these different patterns have yet to be experimentally tested. Moreover, students in Study 1 did not experience actual socio-cognitive conflict and did not actually engage in a learning activity. Therefore, learning gains could not be assessed.

Therefore, the aim of study 2 is to experimentally test the effect of goal instructions on students' behavioral patterns and their conceptual learning gains in actual learning activities that target conceptual change.

Study 2

We are currently in the process of collecting data from an experimental set-up that involves at least forty undergraduate students that participate in an actual learning activity on evolutionary theory. In the present study, we test the effect of different goal instructions on students' patterns of socio-cognitive conflict regulation when asked to discuss and solve learning items with a disagreeing peer. In one condition, goal instructions are articulated in terms of competitive argumentation, whereas in the other the collaborative and constructive nature of dialectical argumentation is emphasized. In addition to the direct effect of such instructions on the interaction, we also assess how they in turn affect individual cognitive gains from the interaction, in the form of conceptual change.

The general procedure and materials for this study are based on and adapted from the Asterhan & Schwarz (2007) study. All students participate in the following sequence of activities: 1) Individual pretest (T1) to assess prior evolutionary understanding; (2) Instructional intervention: screening of instructional movie excerpt on Darwinist evolutionary theory; (3) Individual administration of a single transfer test item (T2); (4) Experimental intervention: Students are instructed to engage in un-scripted, computer-mediated peer argumentation on the T2 test item and a novel transfer item, according to two different sets of goal instructions for collaboration; (5) Post test (T3) immediately following the experimental intervention; (6) Delayed post test (T4) administered a week later. The total length of an experimental session is approximately one and a half hour.

The assessment procedures for conceptual learning gains are based on coding schemes developed by Asterhan and Schwarz (2007). Coding schemes for dialogue analyses are adapted from Asterhan and Schwarz (2009a), and focus not only on the argumentative nature of dialogue moves, but also on affective aspects of interpersonal communication (e.g., Chiu & Khoo, 2003).

Data is currently collected. First findings will be presented and discussed in the presentation.

Conclusions

Previous studies have shown that peer argumentation can be a powerful instigator for conceptual change. However, productive peer argumentation in learning settings is not easily elicited and its benefits are likely to be dependent on a number of preconditions that researchers have begun to identify and investigate. We focused on achievement goal orientations as one such precondition. Achievement goals are sensitive to alterable external factors, such as classroom climate, teacher behavior and task instructions (e.g., Butler, 1993). The results from this research therefore not only benefit theory development, but have practical implication for the field of education as well.

The research presented here should be viewed within the larger framework of the "warming trend" in conceptual change (Sinatra, 2005): Recently, research into conceptual change have started to investigate the role of "hot" constructs, such as topic interest, epistemological beliefs (e.g., Mason, Bodrin & Gava, 2008), and affective factors (e.g., Brem, 2008) in this particular form of learning. We hope to have contributed to this accumulating body of knowledge by focusing on the role of achievement goal orientations.

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