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Social and Cognitive Factors Driving Teamwork in Collaborative Learning Environments

Team Learning Beliefs and Behaviors

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A team is more than a group of people in the same space, physical or virtual. In recent years, increasing attention has been devoted to the social bases of cognition, taking into consideration how social processes in groups and teams affect performance. This article investigates when and how teams in collaborative learning environments engage in building and maintaining mutually shared cognition, leading to increased perceived performance. In doing so, this research looks for discourse practices managing the co-construction of mutually shared cognition and reveals conditions in the interpersonal context that contribute to engagement in these knowledge-building practices. A comprehensive theoretical framework was developed and tested. The constructs in the model were measured with the Team Learning Beliefs & Behaviors Questionnaire and analyzed using regression and path analysis methodology. Results showed that both interpersonal and sociocognitive processes have to be taken into account to understand the formation of mutually shared cognition, resulting in higher perceived team performance.

Keywords: *team learning; collaborative learning; mutually shared cognition; sociocognitive processes*

Groups of people are increasingly acknowledged as the source of knowledge construction. It is expected that teams, bringing together people with different experiences, values, and knowledge, will be more effective in adequately solving the problems than are individuals. However, to be able to adequately solve problems, they face the challenge of integrating these different perspectives and developing a shared understanding of the problem at hand. This can be established through rich interaction, interactive discussion, and negotiation (Daft & Weick, 1984; Roschelle, 1992). The continuing implementation of group work at schools and of teamwork in organizations are instances of attempts to build on the potential of teamwork. To learn from each other and therefore perform well on the ascribed tasks, collaborative learning environments are used. However, research and practice shows that this potential effectiveness is not always reached (e.g., Barron, 2003). Research has revealed cases in which large variation in group work interaction and performance is encountered between teams that seem not to differ in composition and assigned task (Barron, 2000). This research indicates that fruitful collaboration is not merely a case of putting people with relevant knowledge together. Understanding is required in the factors that make up successful collaboration.

This article leans on two primary perspectives on collaborative work and learning as identified by Olivera and Straus (2004), namely cognitive and social. The cognitive perspective stresses the influence of group work on cognitive processes and is dominant in research in educational sciences querying processes affecting cognitive outcomes in collaboration (e.g., Barron, 2003; Webb & Palincsar, 1996). The social perspective examines the social factors constituting successful performance in group work and teamwork and is primarily used in social and organizational research (e.g., Cohen & Bailey, 1997; Edmondson, 1999). Although these two perspectives on collaboration are profoundly intertwined, most research focuses only on one of them (Kreijns, Kirschner, & Jochems, 2003). The current study makes a contribution to the literature by providing a theoretical framework for conceptualizing learning in collaboration that entails both an understanding of how sociocognitive processes give rise to cognitive development and an understanding of the social, interpersonal dimension of teamwork. This is done by taking a group-level perspective on the interactions that give rise to mutually shared cognitions and by integrating this with findings on the importance of interpersonal, social factors as described in social and organizational research. The following introduction sketches the backgrounds and strengths of both approaches and

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shows how these perspectives can be complementary in providing insight in successful collaboration. This will lead to the development of a team learning model that integrates insights of both perspectives.

Cognitive and Social Perspectives on Group Learning

Cognitive research to date has established that knowledge structures affect information processing in predictable ways. The importance of domain-specific knowledge has especially been identified as the prime determinant of excellent performance across many different expertise domains (Ericsson & Smith, 1991; Patel, Arocha, & Kaufman, 1999; Schmidt & Boshuizen, 1993; Sternberg, 1999). This area of research concentrates on how individuals process information, how they assess and interpret situations, and how they solve problems. With the increasing interest in teamwork, the question of how these individual cognitions become integrated and coordinated at the interindividual level becomes of central interest (Wong, 2003). In this perspective, the construction of mutually shared cognition (i.e., shared conception of the problem) lies at the heart of collaboration (Barron, 2003; Roschelle, 1992). This implies that studying group performance requires an analysis of the sociocognitive processes within the group. As Langfield-Smith (1992) has argued, to understand how collective knowledge structures are formed, it is a basic requirement that one must understand the interaction between cognition and social processes.

In the past, research on collaborative learning has particularly focused on determining the structural conditions leading to better outcomes. Conditions hereby investigated are group composition, group size, nature of the tasks, and so on (Dillenbourg, Baker, Blaye, & O'Malley, 1996; Webb & Palincsar, 1996). Although general effects of these structural factors are indeed established in research, it is acknowledged that it is difficult to determine the immediate impact of these structural conditions on the effect of group work (Dillenbourg et al., 1996; Webb & Palincsar, 1996). Therefore, increasing attention is now being paid to the intermediate processes that give rise to effective collaboration. Barron (2003) points out that this entails an articulation of how characteristics of the interaction (discourse practices) interact with knowledge-building processes that lead to mutually shared cognition.

Exemplary for this strand of research looking for patterns of interaction is the work on help-related behavior in cooperative groups (Webb, 1991). In this research, interactions were described by assessing how elaborated was the help that was provided by group members (ranging from giving the answer to giving a detailed explanation). One of the findings was that the

explainers' problem-solving performance benefits from giving elaborated explanation and not from giving nonelaborated help. This stream of work analyzes group work in terms of speech act catalogues and interprets these in terms of impact on individual psychological functioning (Crook, 1998; Dillenbourg et al., 1996). The focus on individual performance is logical because it is mostly the individual who is assessed (Barron, 2000). However, within the perspective that successful collaboration requires mutually shared cognition, this view is limited (Barron, 2000).

To understand differences in collaborative outcomes beside measures of individual functioning, we also need to gain insight in the functioning of the group, more precisely how they manage to collaboratively construct mutually shared cognition and how they work out problems together (Barron, 2000). Research on collaborative learning needs to focus onto the sociocognitive processes through which a shared conception is built. Insight needs to be gained in the conversational patterns at the group level, instantiating the sociocognitive processes that contribute to the development of mutually shared cognition. However, only a few studies of collaborative learning have examined how groups of people create or develop mutually shared cognition (Crook, 1998; Roschelle, 1992).

These sociocognitive processes taking place through discursive practices do not occur in a vacuum but are influenced by the social context in which they take place (Keyton, 2000). It is this social context that nourishes the willingness to engage in the (joint) effort to build and maintain mutually shared cognition (Barron, 2003; Crook, 1998). A case in point is the research from Barron (2003), who concluded from her multiple case studies on sixth-grade triads that relational aspects of the interpersonal context need to be taken into account to understand what happens in learning groups. These groups have to deal with what Barron calls both a relational space and a content space, which compete for limited attention. Her case study on less successful groups indicates that relational issues such as competitiveness and friendships can hinder or stimulate the group, respectively, in dealing with the insights that are constructed in the group.

How the social context influences sociocognitive processes in collaborative groups remains largely uninvestigated in educational psychology. Webb and Palincsar (1996) argue in their hallmark review that

> although social and organizational psychology has documented a great number of debilitating processes that inhibit group functioning and performance in out-of school settings, only a few researchers have investigated debilitating processes in educational settings that may be detrimental for learning. (p. 855)

Examples from research in organizational psychology demonstrating that interpersonal factors—next to structural factors—play a salient role at the professional workplace are the studies from Lingard, Reznick, Espin, Regehr, and DeVito (2002) and Edmondson (1999). Edmondson showed, for example, that experiencing psychological safety in hospital teams shapes individual and team learning behavior. However, research in these domains seldom analyzes the processes through which these factors influence performance.

This article examines a team learning model specifying when and how teams in collaborative learning environments engage in building and maintaining mutually shared cognition, leading to increased perceived performance. This model presents an integrative perspective, building on the strengths of different research strands. It includes both discourse practices that manage the co-construction of mutually shared cognition and conditions in the interpersonal context that contribute to engagement in these knowledge-building practices.

First, we elaborate on this team learning model. This will be followed by the presentation of the field study that has tested this model.

Building a Team Learning Model

The presented theoretical framework is shaped by two complementary perspectives. First, collaborative learning will be analyzed as a fundamentally social process of knowledge building. We will present our view on collaborative learning and the characteristics of the discourse in which collaborative knowledge building is taking place. This perspective will be complemented by a description of crucial aspects of the social environment in which this learning takes place and by which this learning discourse is potentially influenced.

Collaborative Learning as Promoting Conceptual Understanding Through "Mutually Shared Cognition" (Webb & Palincsar, 1996)

In a collaborative learning environment, participants are brought together to simultaneously work on a task to learn from this task work and teamwork. This article focuses on groups for which this task performance is the primary objective and in which the learning is considered a product of this collaboration for task performance. In this way, learning through collaboration is primarily a group-level phenomenon (Dillenbourg et al., 1996). Collaboration is defined as the process of building and maintaining a shared conception of a problem or task, distributing responsibility across members

of the group, sharing expertise, and mutually constructing and negotiating cognition (Roschelle, 1992).

From this viewpoint, the interaction among members of the group and the characteristics of their discourse is considered the process through which mutual understanding and shared cognition is reached. This social process of building mutually shared cognition is called the learning behavior of the team. In this process, negotiation is key to determining which kind of interactions, which patterns in discourse, can be considered to be forms of team learning behavior leading to mutually shared cognition (e.g., Baker, 1995; Dillenbourg et al., 1996). Negotiation here is seen as the process of achieving agreement among agents (Galliers, 1989, cited in Baker, 1995). Baker (1995, 1999) points out that achieving "real" agreement presupposes joint understanding whereby two aspects are highly relevant. First, inserting meaning into the problem faced and solving it requires co-construction; this cannot be done through simple accumulation of the contributions of individuals because each contribution is presumed to build on previous ones. Second, agreement needs to be established on the proposed meanings and solutions (Baker, 1995, 1999).

These two team learning processes through which the group perspective is built are elaborated on below.

Construction and Co-Construction of Meaning

The process of building a shared conception of a problem, as we defined collaboration to be, starts with the articulation of personal meaning that is taken up in the social setting (Stahl, 2000). This process starts when one of the team members inserts meaning by describing the problem situation and how to deal with it, hereby tuning in to the fellow team members. These fellow team members are actively listening and trying to grasp the given explanation by using this understanding to give meaning to the situation at hand (Webb & Palincsar, 1996). We refer to these processes as construction of meaning.

These processes of construction of meaning can evolve into collaborative construction (co-construction), a mutual process of building meaning, by refining, building on, or modifying the original offer in some way (Baker, 1994). The outcome of this process is that new meanings in the collaborative work that were not previously available to the group emerge.

Toward Agreement: Constructive Conflict

Mutually shared cognition is developed when agreement is reached around the (co-)constructed understandings. It is not sufficient that the inserted meanings are clarified and that there is mutual understanding; they

must also be accepted before they form the base for action (Alpay, Giboin, & Dieng, 1998). If accepted, the offered meaning can become part of the common ground, the agreed-on interpretation of the situation, in other words, the mutually shared cognition. However, the team members may diverge in their interpretation and tackle the situation from another point of view or perspective. This rejection of the built understanding can lead to a further elaboration through the negotiation of the different meanings. However, Hewson and Hewson (1984), and more recently De Dreu and Weingart (2003), argued that the emergence of differences in opinion does not guarantee conceptual advancement because it may be taken as a paradox and resolved by ignoring one of the elements. Another argument is that it may not be seen as a difference in the interpretation of the problem but as a personal, emotional rejection and as such can interfere with productive team behavior (De Dreu & Weingart, 2003). So disagreement or divergence in itself seems to be less important than the fact that it generates communication among peer members (Dillenbourg et al., 1996). The team will only benefit if divergence in meaning leads to further negotiation. Through this negotiation by argument and clarification, the team works toward a convergence of meaning, and mutually shared cognitions are reached. Therefore, we define constructive conflict as negotiation of the differences in interpretation among team members by arguments and clarifications.

The following hypothesis may be formulated based on the arguments made above:

Hypothesis 1 (H1): Increasing (co-)construction and constructive conflict in the interaction of the team will positively influence the development of mutually shared cognition.

In organizational science literature, there is a lot of interest in mutually shared cognition as a group-level cognitive construct (Akkerman et al., 2005). This interest is mainly driven by the idea that it plays an important role in explaining the effectiveness of teams (Klimoski & Mohammed, 1994). Mutually shared cognition creates a context for efficient group decision making. First, group members engage in a context that offers possibilities to learn from others' preferences and viewpoints by knowing that there are different viewpoints, by accepting the existence of alternative viewpoints as legitimate, and perhaps by considering them in their own viewpoints (Engeström, Engeström, & Kärkkäinen, 1995). Second, the development of shared cognition facilitates coordinated action because it ensures that all participants are solving the same problem and helps exploiting the cognitive

capabilities of the entire team (Orasanu, 1990, cited in Klimoski & Mohammed, 1994). Third, the active use of different views in working on and solving problems may entail a consideration of more alternatives and a richer argumentation, and thereby the nature of communication itself and problem solutions may become more creative.

A broad approach to effectiveness is taken to grasp these potential effects of developing mutually shared cognition on team effectiveness. Hackman (1989) conceptualized the multiplicity of outcomes that matter in organizational settings in three ways. Not just the performance is of importance, both in terms of process and product. This means both the extent to which the team was capable of collaboratively tackling the task at hand (process) and the degree to which the team output meets the standard of quality (product) are of importance. Also, the degree to which the process of carrying out the work enhances the capability of members to work together in the future (viability) and the degree to which the team work contributes to the professional growth of the team members (learning) need to be taken into consideration. Also, from a professional education perspective, these three dimensions are of crucial importance: The individual growth is important, but also the performance and the team viability are of importance because these show that students also have the competence to produce a good product and deal with the complex situation of team learning.

Based on these insights, the following hypothesis can be formulated:

Hypothesis 2 (H2): More developed mutually shared cognition in a team will result in higher team effectiveness.

Groups as Social Systems: Beliefs About the Interpersonal Context

It follows from our argumentation that it is important to determine under which conditions the described interactions occur. Roschelle and Teasley (1995) conclude that "collaboration does not just happen because individuals are co-present; individuals must make a conscious, continued effort to coordinate their language and activity with respect to shared knowledge" (p. 94).

The identification of the social conditions under which teams make this effort to reach shared knowledge is an essential prerequisite for developing enhanced understanding of successful collaboration. Viewing collaborative learning as reaching mutually shared cognition, and thus as fundamentally social, stresses the need to take into account the social context in which these processes take place.

Salomon and Globerson (1989) point to the fact that most social effects arise from the evolution of the group as a social system. Shared beliefs of the team characteristics emerge in groups from the interaction among the team members (Arrow, McGrath, & Berdahl, 2000).[1] As such, those beliefs are group-level variables, characteristics of the team more than of the team members (Edmondson, 1999). This article focuses on emerging team-level beliefs about the relations among the team members, in other words, beliefs about the interpersonal context. The main question to be dealt with is: How does this team perceive the interpersonal context formed by their team? Subsequently, these beliefs will influence the behavior of the team (Cohen & Bailey, 1997) and, more specifically, the learning behavior of the team. It is supposed that they form a context that stimulates or inhibits learning behavior. The question that now arises is how to identify beliefs about the interpersonal context that influence learning and cognitive development in teams (Webb & Palincsar, 1996).

As Webb and Palincsar (1996) noted, few researchers have investigated these kinds of factors in educational settings that influence group learning. However, ample research in social and organizational psychology focuses on the role of beliefs about the interpersonal context in group functioning and performance in out-of-school settings (e.g., Cohen & Bailey, 1997). Powerful group-level beliefs identified in this research, that potentially affect the learning behavior in teams, are psychological safety, cohesion, potency, and interdependence. These four will be elaborated on in the following paragraphs, showing their meaning and their hypothesized influence on team learning behavior and performance.

Psychological Safety

Learning in groups can be threatening and stressful (Homan, 2001): Team members do not know each other, power games are played, people are left out, people blame each other for making mistakes, and so on. The paradox, however, is that learning is often facilitated by taking risks and thinking freely. The notion of psychological safety, as such, is not new. In early research on organizational change, Schein and Bennis (1965) recognized the need to create psychological safety for individuals if they are to feel secure and capable of changing.

However, in her work on organizational learning and teamwork, Edmondson (1996, 1999), one of the few researchers directly analyzing the effect of beliefs about the interpersonal context on team learning behavior, pointed to the importance of team psychological safety as a facilitating interpersonal context for team learning behavior. Team psychological safety is

defined as a shared belief that the team is safe for interpersonal risk-taking (Edmondson, 1999).

> The term is meant to suggest neither a careless sense of permissiveness, nor an unrelentingly positive affect but rather a sense of confidence that the team will not embarrass, reject, or punish someone for speaking up. This confidence stems from mutual respect and trust among team members. (Edmondson, 1999, p. 354)

She argues that team psychological safety is said to facilitate learning behavior in teams because it alleviates excessive concern about others' reactions to actions that have the potential for embarrassment or threat, which learning behaviors often have. Psychological safety does not play a direct role in the team's performance; it facilitates appropriate behavior leading to better performance (Edmondson, 1999).

Hypothesis 3 (H3): Psychological safety is positively associated with team learning behavior.

Cohesion

Cohesion has been widely studied as an important aspect of group functioning. Festinger (1950), as one of the earliest researchers of this construct, defined cohesion as "the resultant of all the forces acting on all the members to remain in the group" (p. 274). Two meta-analytic studies have indeed revealed that a small but positive relationship exists between group cohesion and group performance (Evans & Dion, 1991; Mullen & Copper, 1994).

Cohesion is a multidimensional construct. As research proceeded, different types of cohesion were distinguished, the most important of which is the distinction between task cohesion and social cohesion. Mullen and Copper (1994) operationalize it as cohesion because of the commitment to the task and cohesion because of the interpersonal attraction. Task cohesion refers to the shared commitment among members to achieve a goal that requires the collective efforts of the group. Social cohesion refers to the nature and quality of the emotional bonds of friendship such as liking, caring, and closeness among group members. They pictured the mechanisms by which these types of cohesiveness might affect performances as follows. If the cohesiveness-performance effect is primarily because of interpersonal attraction, group members will exert efforts toward performance for

the sake of their well-liked group members. If the effect is primarily because of commitment to the task, group members will exert efforts toward performance for the pleasure of completing that task.

Their meta-analytic study indicated that task cohesion appears to be the critical and primary component of cohesiveness in the cohesiveness-performance effect, suggesting that teams that perform well are committed to successful task performance and regulate their behavior toward that end. Some studies even state that social cohesion can be detrimental by invoking "groupthink" (Janis, 1972), whereas task cohesion prevents groupthink from occurring. However, research following this study has showed that the relation is not always that consistent and has pointed out that social cohesion is potentially a predictor of team viability, another desirable outcome of teamwork (Chang & Bordia, 2001).

All this leads us to hypothesize that task cohesion will be positively associated with learning behavior because high task motivation shows the existence of shared goals and the motivation to strive for it. It regulates the (learning) behavior that fosters the achievement of these goals. The relation of social cohesion with learning behavior seems more complex. On the one hand, it promotes learning behavior because it increases the willingness to help each other, whereas on the other hand, high social cohesion could lead to uncritical acceptance of solutions.

Hypothesis 4a (H4a): Task cohesion is positively related to team learning behavior.
Hypothesis 4b (H4b): Social cohesion is not related to team learning behavior.

Interdependence

Interdependence is one factor that is heavily studied in both educational (e.g., Johnson & Johnson, 1989; Mesch, Marvin, Johnson, & Johnson, 1988) and organizational (e.g., Wageman, 1995) sciences. A classic distinction made is one between task interdependence and outcome interdependence. Task interdependence (initiated and received) refers to the interconnections among tasks such that the performance of one definite piece of work depends on the completion of other definite pieces of work (van der Vegt, Emans, & van de Vliert, 1998). Studies have shown that task interdependence leads to more communication, helping, and information sharing than individualistic tasks (Crawford & Gordon, 1972; Johnson, 1973). Some findings suggest that this interdependence is related to experienced responsibility for the work of others (Kiggundu, 1981). This in turn leads to a shared responsibility on the team level.

Outcome interdependence is defined as the extent to which team members' personal benefits and costs depend on successful goal attainment by other team members (van der Vegt et al., 1998). Concerning this construct, findings indicate that teams working under circumstances of positive outcome interdependence are more open minded regarding others' arguments and desires, more concerned about each other's outcomes, and more inclined to search for solutions and compromises (e.g., Deutsch, 1980; Johnson & Johnson, 1989). So both outcome interdependence and task interdependence seem to lead to a shared responsibility on the team level and influence the level of cooperative social interaction in teams (Wageman, 1995). Wageman (1995) concludes in her study that whenever collaborative behavior is important to excellent task performance, high task interdependence supported with reward interdependence is critical. Gully, Incalcaterra, Johi, and Beaubien (2002) point out that empirical evidence supports the notion that task and outcome interdependence tap into a general interdependence factor conjointly influencing the behavior of the team. Following Johnson and Johnson (1989), Wageman, and van der Vegt et al. (1998), we focus on the effect of perceived task and outcome interdependence.

Hypothesis 5 (H5): Task and outcome interdependence will be positively related with learning behavior.

Group Potency

Based on the idea of the role of self-efficacy in individual performance (Bandura, 1982), researchers have conceptualized group potency as a key determinant of team performance outcomes (Shea & Guzzo, 1987b). Group potency has been defined as "the collective belief of group members that the group can be effective" (Shea & Guzzo, 1987a, p. 26). This means that it is a group-level phenomena and a general, overall belief about the ability to be effective (Gully et al., 2002; Hecht, Allen, Klammer, & Kelly, 2002). It is stated that positive evaluations of the team's potency are expected to have positive effects on collective motivation and performance (Cohen & Bailey, 1997; Sargent & Sue-Chan, 2001).

Recently, Gully et al. (2002) reviewed the body of research on the concept of group potency and affirmed the positive relationship between group potency and team performance. However, this research work has not specified the processes through which shared perceptions of potency lead to good performance (Edmondson, 1999). A possibility is that potency fosters a team's confidence (Edmondson, 1999; Gully et al., 2002) and so determines whether

a situation is framed as a possible threat or as an opportunity. The sense of confidence generated by high levels of potency is believed to help teams persevere in the face of adversity (Gully et al., 2002). This will influence the ability of a team to effectively regulate team processes and share and process information (Gully et al., 2002). Edmondson's (1999) research itself can give us some indications about these mechanisms. She found that team efficacy (resembling group potency) is positively associated with team learning behavior.

Hypothesis 6 (H6): Group potency is positively related to team learning behavior.

Until now, most research studied the identified factors in isolation. So the question remains how these factors relate among themselves. We hypothesize that the identified shared beliefs are complementary. This means that each of the four shared beliefs has additive positive effects on the occurrence on team learning behaviors: a shared commitment toward the task at hand (task cohesion), the belief that they need each other for dealing with this task (interdependence), the belief they will not be rejected for bringing in new meanings (team psychological safety), and the belief that the team is capable of using this new information to generate useful results (team potency).

Team Learning: A Model

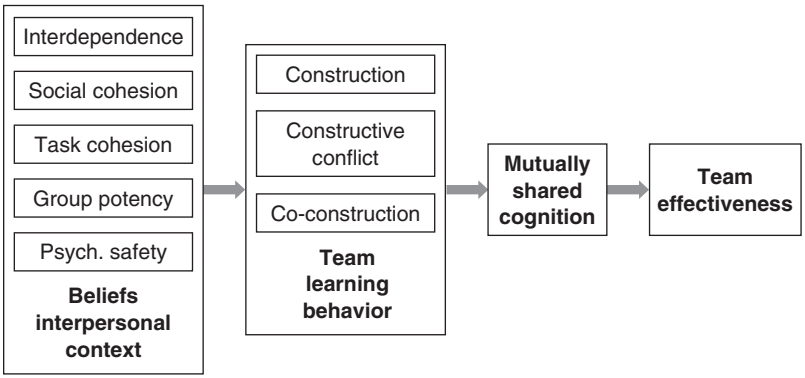
The above-presented constructs fit into a model of collaborative work in which beliefs about the interpersonal context shape the willingness to engage in learning behavior. Learning behavior is defined as processes of construction and co-construction of meaning, with constructive conflict as a vehicle to enhance (co-)construction. This learning behavior gives rise to mutually shared cognition, leading to higher team effectiveness. The above-stated hypotheses can be summarized in the model presented in Figure 1.

Method

Setting and Procedure

The study took place in two 1st-year bachelor courses (logistics and international economics) of an international business degree program in the

Figure 1
Team Learning Beliefs and Behaviors—Model



Netherlands. The students in these courses had two semesters of prior experience in working in groups. As a course requirement, students formed groups to work on an assignment during a 7-week period in a face-to-face setting. In one of the courses, the groups were created by the teachers; in the other course, the groups were self-selected. This assignment consisted of advising a company or institution on its strategy, resulting in a paper and a presentation. This assignment was comparable over the two courses; only the context of the problems was specific for the two courses. The questionnaire was administered in the last week of the course. The following instructions were given to team members before they completed the scales: "Please indicate to what extent you agree with the following statements concerning the team in which you are working and the task with which you are dealing."

Participants

Data were collected from 99 teams. Data were analyzed from only those teams that had a response of at least two thirds of the team members (this was possible because group-level constructs were measured; the different individuals in the team can be seen as "repeated measures"). A total of 75 teams were selected for analysis. These teams had an average out of 3.45 members (SD = 0.68, range = 3 to 5), and on average 0.49 data of team members were missing (SD = 0.43). On average, 36% of the team members were female.

Instrumentation

Constructs in the model were measured with a questionnaire (Team Learning Beliefs & Behaviors Questionnaire) composed of scales taken from validated questionnaires. The selection of instruments was guided by two criteria. First, the chosen instrument had to measure the same construct (i.e., the construct that was originally measured had to be conceptually identical to the way the construct was defined in the team learning model). Second, the psychometric qualities of the selected instrument had to be high. The resulting questionnaire was thoroughly reviewed by experts and was cognitively pretested with a group of students to make sure the composed questionnaire was adapted to the situation (American Statistical Association, 1997).

Assessment of the psychometric properties was carried out through principal component analyses (varimax rotation with eigenvalues of 1.0 or above) of the scales connected to the same level of the model to confirm the uniqueness of the scales with respect to each other. This was supplemented by the computation of the internal consistency reliability of the scales (Cronbach's α). These analyses were executed using the individual participants' responses (Nunally & Bernstein, 1994).

In the next paragraphs, the different sections of the questionnaire are described, pointing out the scales out of which they are composed. Also, the results of the assessment of the psychometric properties are reported. This is followed by the presentation of the intercorrelations and internal consistency of the scales used in the main analysis.

Team Learning Behaviors

Our conception of collaborative learning leads to a focus on conversational actions enabling team members to become partners in the construction of shared knowledge (Roschelle, 1992). These conversational actions refer to the three aforementioned aspects of the learning behavior (construction, co-construction, and constructive conflict). These aspects were measured by means of nine items from three questionnaires. Items were formulated based on the questionnaire of Visschers-Pleijers, Dolmans, Wolfhagen, and Van der Vleuten (2003), measuring learning processes (exploratory questions, cumulative reasoning, and handling conflicts) in a collaborative learning context. This was completed with questions measuring perceptions of learning processes from the Edmondson (1999) questionnaire and the Van Offenbeek (2001) questionnaire to cover the full range of identified learning behaviors.

Examples of items operationalizing these learning behaviors are, "Team members are listening carefully to each other" (construction), "Information

from team members is complemented with information from other team members" (co-construction), and "This team tends to handle differences of opinions by addressing them directly" (constructive conflict).

The factor analysis revealed one factor on which all items loaded high (minimum = .66). Also, the internal consistency was high, with an alpha of .88. This shows that these items tap into a general construct that can be defined as team learning behavior.

Beliefs About the Interpersonal Context

Psychological safety. For measuring psychological safety, Edmondson's (1999) questionnaire was used. Sample items for psychological safety include, "No one in this team would deliberately act in a way that undermines my efforts" and "It is safe to take a risk in this team."

Interdependence. Questions measuring interdependence were based on the scales and items developed and used by van der Vegt et al. (1998). This questionnaire contains 12 items. Those items that marked the variable were selected, and parallel items were deleted from the scale. The degree of perceived task interdependence was measured using two items (e.g., "I depend on my team members for information and advice."). The scale measuring outcome interdependence was also covered by two items (e.g., "When my team members succeed in their jobs, it works out positively for me.").

Cohesion. Social cohesion was measured using a scale developed by Sargent and Sue-Chan (2001), measuring this construct and containing four items. Sample items include, "I like my team" and "I feel a sense of belongingness to my team." Task cohesion was operationalized using a scale from Carless and de Paola (2000). This scale consists of four items, including, for example, "This team is united in trying to reach its goals for performance" and "The team members have conflicting aspirations for the team's performance" (reverse scored).

Group potency. Group potency was measured through a scale also used by Sargent and Sue-Chan (2001) and Gibson, Randel, and Earley (2000). This is an adapted version from a scale originally formulated by Guzzo, Yost, Campbell, and Shea (1993). Examples from the six items in this scale are, "This team has confidence in itself" and "This team can get a lot done when it works hard."

The factor analysis confirmed the scales as measured, except for one of the items of the task cohesion scale, which also loaded highly onto two

other factors, showing the lack of discriminative power. This item was therefore deleted from further analysis. Three items of the psychological safety scale also loaded highly on other factors. Most likely this is a consequence of the broad operationalization of the concept by Edmondson (1999). Therefore, these three items were also deleted. The four remaining items load onto two factors, both conceptually related to the essence of the construct as defined. The analyses of the internal consistency of the scales confirmed this picture. Cronbach's alpha of the scales social cohesion and group potency is .88 and .89, respectively. The interdependence scale's internal consistency is smaller ($\alpha = .64$). This is a consequence of the two slightly different constructs that are measured with this scale: task and outcome interdependence. The internal consistency of task cohesion is hardly damaged by removing one of the items ($\alpha = .79$). The internal consistency of the psychological safety scale is rather low ($\alpha = .50$). This is also a consequence of the two aspects of the construct that are pictured in this scale.

Mutually Shared Cognition

Mulder (1999) developed and used in further research (Mulder, Swaak, & Kessels, 2002) a self-scoring instrument measuring "shared understanding." They defined and used shared understanding analogously to our construct of mutually shared cognition. They measured the perception of shared understanding both at a certain moment (product) and with respect to the development of shared understanding (process). We used only those items referring to the perceived shared understanding at a certain moment. To stress this, we added to the questions "at this moment." Mulder (1999) and Mulder et al. (2002) questioned the understanding of the task and the requirements of the task in one question. We split this up in two items. This resulted in a scale existing of the following items: "At this moment, this team has a common understanding of the task we have to handle" and "At this moment, this team has a common understanding of how to deal with the task."

Factor analysis reveals that both questions load very highly on one factor (minimum = .938). Concomitant with this factor analysis is the high internal consistency of this scale ($\alpha = .86$).

Team Effectiveness

This study examines the impact of team learning beliefs and behaviors on the three dimensions of team effectiveness as defined by Hackman (1989): performance, viability, and learning. This was done through a self-reported,

subjective measure of group performance, a method commonly used in the study of work teams (Chang & Bordia, 2001; Cohen & Bailey, 1997). The above-mentioned dimensions were measured using four items. Two items questioned the first dimension, team performance: one measuring the process ("We have completed the task in a way we all agree upon.") and one measuring the product ("I am satisfied with the performance of our team."). Two more items were used to get a grip on the team viability ("I would want to work with this team in the future.") and team learning ("As a team, we have learned a lot.").

The internal consistency of these four items is high ($\alpha = .88$), and the factor analysis shows that these four items tap into a shared construct. All items have a high factor loading (minimum = .78).

Aggregation on Team Level

The constructs measured in the survey are conceptually meaningful at the team level. Therefore, the data gathered from individual team members to assess these team-level variables needed to be aggregated at that level. The within-group agreement was assessed using the multiple-item estimator r_{wg} (James, Demaree, & Wolf, 1984). This analysis resulted in a mean value of .81 for interdependence, .89 for social cohesion, .76 for task cohesion, .81 for psychological safety, .85 for group potency, .88 for learning behavior, .83 for mutually shared cognition, and .78 for team effectiveness. These results justify the creation of a group-level data set. Descriptive statistics (means and standard deviations), intercorrelations, and internal consistencies of the scales at the team level of analysis are presented in Table 1.

Methods of Analysis

The present study used (multiple) regression and path analysis to identify effects of potentially important theoretical relations. The analysis is presented in three parts. Analogous to the theoretical framework, it first tested whether the part of the model describing collaborative learning as building mutually shared cognition holds. Next, it analyzed whether the identified beliefs about the interpersonal context influence team learning behavior. Finally, it analyzed whether the complete proposed model is acceptable. This was done in two steps. First, the model describing the process leading toward mutually shared cognition was tested. And then the model also including the variable team effectiveness was analyzed.

The first two parts of the analysis were primarily based on (multiple) regression analyses. The last part of the analysis was informed through the

Table 1
Chronbach's Alphas and Intercorrelations Among Team-Level Survey Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Interdependence	5.13	0.51	**.62**							
2. Social cohesion	5.31	0.86	.35**	**.92**						
3. Task cohesion	5.12	0.76	.40**	.70**	**.81**					
4. Psychological safety	4.98	0.56	.53**	.50**	.50**	**.60**				
5. Group potency	4.95	0.73	.32**	.56**	.50**	.58**	**.92**			
6. Team learning behavior	5.34	0.60	.60**	.61**	.60**	.73**	.63**	**.92**		
7. Mutually shared cognition	5.53	0.75	.47**	.59**	.59**	.57**	.40**	.67**	**.89**	
8. Team effectiveness	5.20	0.86	.25*	.78**	.70**	.49**	.66**	.67**	.66**	**.90**

*$p < .05$. **$p < .01$.

path analyses. The adequacy of the models was assessed by LISREL version 8.52 (Jöreskog & Sörbom, 2002). Models were all tested with standardized coefficients obtained from the maximum likelihood method of estimation. To ascertain the model fit, we analyzed the comparative fit index (CFI), the non-normed fit index (NNFI), the standardized root mean square residual (SRMR), and the chi-square test statistic. Values of the CFI and NNFI greater than .90 and .95, respectively, are typically taken to reflect acceptable and excellent fits to the data (Schumacker & Lomax, 1996). The NNFI contains, contrary to the CFI, a penalty for a lack of parsimony of the model (Guay, Marsh, & Boivin, 2003). Hu and Bentler (1999) suggested the use of the SRMR in evaluating the model fit, with values less than .08 as an indication of a relatively good fit between the hypothesized model and the observed data. Only statistically significant paths are included in the presented diagrams.

Results

Part 1: The Cognitive Side of Collaborative Learning

To test the hypothesis that team learning behaviors lead to mutually shared cognition and that this is subsequently related to higher team effectiveness,

Table 2
Regression Models of Outcomes

	Mutually Shared Cognition			Team Effectiveness					
	β	*t*	*p*	β	*t*	*p*	β	*t*	*p*
Team learning behavior	.67	7.644	.000				.41	3.799	.000
Mutually shared cognition				.66	7.514	.000	.39	3.560	.001
Adjusted R^2	.44			.43			.52		

Note: Standardized βs are reported.

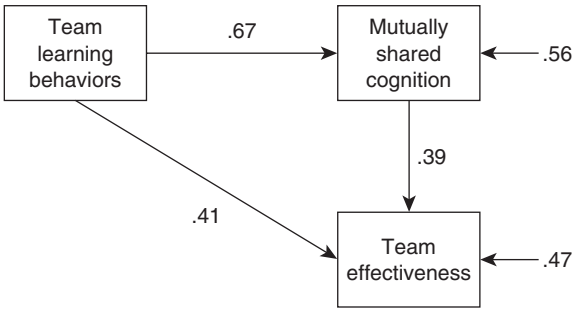
three regression analyses were performed. First, it was tested if team learning behavior significantly predicts the mutually shared cognition as reported by the team. Second, it was analyzed if the reported mutually shared cognition predicts team effectiveness. Finally, it was analyzed if mutually shared cognition mediates the relation between team learning behavior and team effectiveness. For that, the contribution of team learning behavior should drop (for partial mediation) or become insignificant (for full mediation) when entered into the model together with the variable mutually shared cognition (Baron & Kenny, 1986). The results of these computations are presented in Table 2.

Table 2 shows that mutually shared cognition is significantly predicted by team learning behavior ($\beta = .67$, $p = .000$, adj. $R^2 = .44$), providing support for H1. Mutually shared cognition significantly predicts team effectiveness ($\beta = .66$, $p = .000$, adj. $R^2 = .43$), supporting H2. The third regression analysis shows that the relation between team learning behavior and team effectiveness is partially mediated by mutually shared cognition.

Figure 2 pictures the results if the latter analysis is presented as a path model. This is a fully defined and thus completely saturated model. The parameters are the standardized betas in the multiple regression analysis.

This analysis shows that the three team learning behaviors (i.e., construction, co-construction, and constructive conflict) present themselves as knowledge-building activities, resulting in mutually shared cognition. The identified sociocognitive processes give rise to a shared conception of the problem at hand. This mutually shared cognition can be seen as the primary and most profound learning outcome. In turn, this mutually shared cognition is identified as a part of the basis on which team effectiveness is built:

Figure 2
The Cognitive Side of Collaborative Learning



It plays an important role in the total effectiveness of the team. The relation between the team learning behaviors and team effectiveness in the first analysis is only partially mediated by mutually shared cognition.

Part 2: The Social Side of Collaborative Learning

A multiple regression analysis was conducted to analyze if the identified team beliefs of the interpersonal context predict the occurrence of team learning behavior. The results are summarized in Table 3.

Four of the five identified team beliefs significantly and substantially predict team learning behavior: interdependence ($\beta = .254$, $p = .001$), task cohesion ($\beta = .247$, $p = .013$), psychological safety ($\beta = .299$, $p = .002$), and group potency ($\beta = .202$, $p = .020$). As expected, team learning behavior is not determined by social cohesion ($\beta = .083$, $p = .390$). Therefore, this variable will be deleted in the further analyses. These results provide support for H3, H4a, H4b, H5, and H6 and also support the hypothesis that these beliefs are complementary.

This second part of the analysis focused on the relation between the beliefs about the interpersonal context and the team learning behavior. This analysis shows that teams engage in the described sociocognitive processes of team learning behavior under certain conditions. All the identified beliefs about the interpersonal context set the stage for the occurrence of the team learning behavior. Interdependence, task cohesion, psychological safety, and group potency form the context in which teams are motivated to

Table 3
Regression Model of Team Learning Behavior

	β	*t*	*p*	Adj. R^2
Interdependence	.254	3.317	.001	
Social cohesion	.083	0.866	.390	
Task cohesion	.247	2.550	.013	
Psychological safety	.299	3.243	.002	
Group potency	.202	2.376	.020	
				.70

Note: Standardized βs are reported.

display the crucial learning behavior. Social cohesion is the only measured belief that does not seem to play a role in this context. Based on the evidence displayed in the literature, this was to be expected: Task cohesion is the more important aspect of cohesion, in general, in predicting productive team behavior.

Part 3: Testing the Model

The full team learning model was tested in two steps. A first model explains the development of mutually shared cognition and does not include team effectiveness. The second does include the variable team effectiveness.

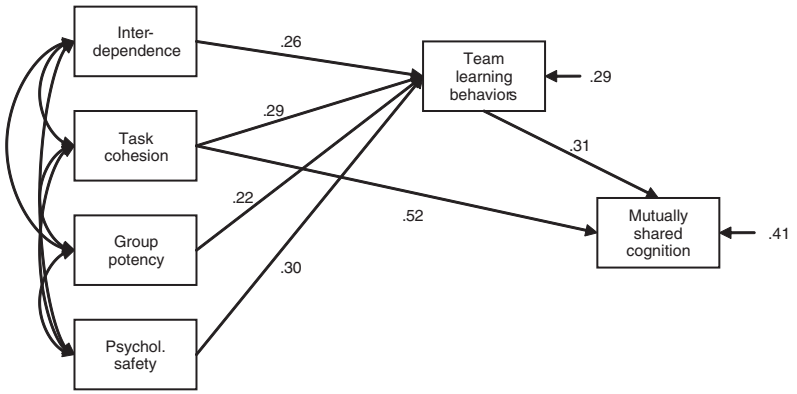
Toward a Model of Mutually Shared Cognition

The originally hypothesized model is composed of paths leading from the four constructs measuring beliefs toward team learning behavior and a path from learning behavior toward mutually shared cognition. Though the fit of this model is acceptable for some of the indicators, this can be improved ($\chi^2 = 21.71$, $df = 4$, $p < .05$, CFI = 0.94, NNFI = 0.76, SRMR = 0.065).

Inspection of the modification indices (Sörbom, 1989) suggests one additional path between task cohesion and mutually shared cognition. This model, pictured in Figure 3, fits the data even better ($\chi^2 = 3.08$, $df = 3$, $p = .38$, CFI = 1.00, NNFI = 1.00, SRMR = 0.022).

This model is most important and interesting if one looks from an educational point of view because in this model one can see the factors that are influencing the cognitive outcomes of team learning: the mutually shared

Figure 3
Model Toward Mutually Shared Cognition



cognition that is built through participating in the team learning activities. This is, in other words, the cognitive residue or the conceptual development resulting from team learning.

The model as confirmed by the data shows that the beliefs about the interpersonal context support the team learning behavior, which in turn gives rise to mutually shared cognition. It is important to see that the influence of the beliefs on shared cognition is through the learning behaviors espoused by the team. The only exception is task cohesion, which has also, next to an indirect relation, a direct relation with the rise of mutual shared cognition. The shared commitment toward the task seems to have effects on mutually shared cognition that are not grasped by the learning behaviors alone.

Toward a Model of Team Effectiveness

First, the model presented in Figure 3 was extended with the variable team effectiveness, including a path from mutually shared cognition to team effectiveness. However, the fit indices show that this model is not probable ($\chi^2 = 43.29$, $df = 8$, $p < .05$, CFI = 0.91, NNFI = 0.77, SRMR = 0.096). Inspection of the modification indices (Sörbom, 1989) showed that two additional paths are necessary: one path from task cohesion toward team effectiveness and one path from group potency to team effectiveness.

Figure 4
Model Toward Team Effectiveness

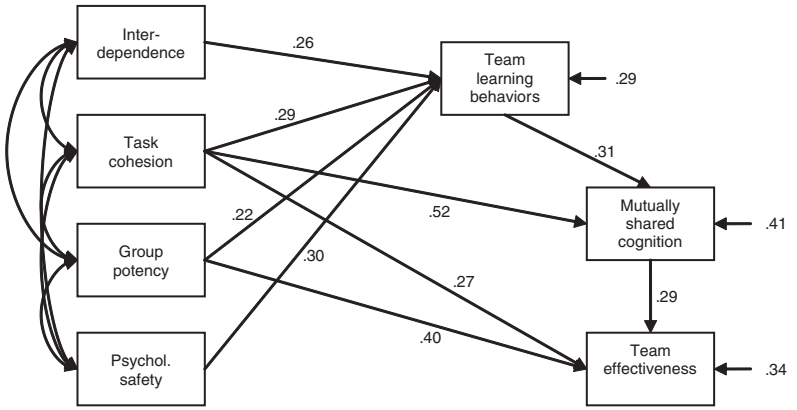


Figure 4 contains this adapted model. The values of the fit indices indicate an acceptable fit of the path model applied to the data. The chi-square becomes significant ($\chi^2 = 13.18$, $df = 6$, $p = .04$), but all the other fit measures show that this model is acceptable (CFI = 0.98, NNFI = 0.94, SRMR = 0.031). These findings argue for the appropriateness of the model structure as shown in Figure 4.

The effectiveness of the team is influenced by the mutually shared cognition that is a result of the team learning behaviors of the team. This means that the data collected through the Team Learning Beliefs & Behaviors Questionnaire confirm the hypotheses underlying the team learning model as presented. The only modifications that needed to be made were (a) an extra path from task cohesion to team effectiveness and (b) an extra path from group potency to team effectiveness. Both adjustments seem theoretically acceptable. This is probably because a high shared commitment to the task and a high group potency of the team will probably show itself also in other team behavior leading to effectiveness that is not fully grasped by the identified team learning behaviors.

It can be pointed out that these analyses show that the relation between team learning behaviors and team effectiveness is fully mediated by mutually shared cognition (see Figure 4). In the previous analysis presented in Part 1 of the results, this relation was only partially mediated by mutually

shared cognition. This seems evident in the light of the fact that a part of the relation between team learning behavior and team effectiveness can be classified as spurious as a consequence of the relation of task cohesion and group potency with both team learning behavior and team effectiveness. Therefore, this spurious relation is elapsed in this last analysis in which the complete model is tested.

Conclusion and Discussion

These results have a number of theoretical and practical implications. The team learning model as presented and tested in this article is constituted by integrating ideas from different research strands. Conclusions and implications can be drawn for each of them.

Collaborative learning was conceptualized as the creation of mutually shared cognition. Discourse patterns were considered sociocognitive processes through which mutually shared cognition is constructed. We identified these processes as team learning behaviors and framed them as construction, co-construction, and constructive conflict. The results of this study show that this approach makes it possible to grasp team learning processes toward mutually shared cognition.

This article argued, together with Roschelle and Teasley (1995), that these team learning behaviors do not take place just by putting people together. Interpersonal context needs to be taken into account to understand the engagement of team members to coordinate their understanding. To identify some crucial aspects of the interpersonal context, we have made use of research in organizational and social psychology. The identified aspects such as interdependence, task cohesion, psychological safety, and group potency turned out to be crucial for the engagement in team learning behavior in teams, which in turn gives rise to mutually shared cognition, in turn leading to higher perceived team effectiveness. The results of this research show that constructs and insights from organizational science concerning beliefs about the interpersonal context in teams are transferable to collaborative learning in educational settings. More specifically, the results suggest the importance of a team belief such as psychological safety for learning: It seems to open the possibility to engage in learning behavior that asks team members to build on and to disagree with each other (Edmondson, 1999). Wegerif (1998) noted that

> forming a sense of community, where people feel they will be treated sympathetically by their fellows, seems to be a necessary first step for collaborative

> learning. Without a feeling of community people are on their own, likely to be anxious, defensive and unwilling to take the risks involved in learning. (p. 48)

Also, beliefs as task cohesion and interdependence seem to promote learning processes; task commitment, supplemented with shared responsibility, drives people to collective learning processes. Furthermore, a high group potency belief strengthens the idea that investment will pay off and so encourages processes of learning. Conversely, our results underline the potential of a group learning perspective in understanding the processes that mediate the effect of these interpersonal factors on performance. They underpin the results of Edmondson (1999), showing the richness of a team learning approach, and extend them by incorporating different beliefs about the interpersonal context and by conceptualizing the team learning behavior from the perspective of building mutually shared cognition. All this means that linkages between educational and organizational science have the potential to yield additional insights in the development of shared cognition and performance in teams.

Moreover, the results of the present research suggest practical consequences for both students and professionals in teams. Because collaborative learning formats are frequently used in education for the professions and because teamwork is omnipresent in those professions, teachers and managers need to pay explicit attention to the basic requirements for fostering interpersonal processes and beliefs that promote learning (e.g., Smith, 1996). This entails that students and professionals need (to learn how) to cope with these beliefs about the interpersonal context and processes. This research suggests different pathways in the interpersonal context where attention can or needs to be focused if knowledge building is sought. Possible handles can be sought in task design and/or assignment, leadership, and allocating time for group development.

Also, this research sheds light on the cognitive demands of teams in dealing with the framing of the task or problem at hand; one needs to deal with both understanding and agreement. This means that room for construction, co-construction, and constructive conflict needs to be made in the process of reaching mutual shared cognition. This can involve slowing down the interaction to inquire about meanings and test understandings (Argyris & Schön, 1996; Marsick, Watkins, & Wilson, 2002). Also, conflicts need to be seen as windows of opportunity instead of threats to progress. By taking them as conflicts around the interpretation of a problem, they can be the motor of further communication (Dillenbourg et al., 1996). Through this negotiation, mutually shared cognitions are constructed.

Limitations and Issues for Future Research

The present study is founded on perceptions of the team members. Future research should try to establish how perceptions of mutually shared cognition relate to measurements more informed by cognitive sciences. Hereby, the challenge will be to directly measure the mutually shared cognition of a team (for a review, see Akkerman et al., 2005). Also, one can question how perceptions of the team learning behaviors are related to the concrete behaviors of team members. To deal with this concern, we used multiple observers (i.e., the different team members). Furthermore, one can question who the best observer of this team learning behavior is (the team members or an external observer), hereby keeping in mind that this external observer adds nothing more than an extra perception of the situation (and who is best capable of evaluating if, for example, a critical question is posed?). Moreover, consistency is found between the self-reported learning behaviors and the learning behaviors as reported by an external observer (Edmondson, 1999). Also, the research design can be expanded with more objective measures of team effectiveness. For example, the team performance can be assessed by experts. The performance on transfer tasks (new assignment and/or members in a new team) can give further insight in the professional development of the team. And indications of system viability maybe can be found in behavioral measures as absenteeism and dropout (Cohen & Bailey, 1997).

Further research also needs to be directed at the extra paths that are included in the team learning behavior model. Paths were added from task cohesion and group potency toward team effectiveness. These paths suggest processes leading toward team effectiveness that are not included in the team learning behaviors. Research should shed light on the processes underlying these paths in the model as we know it. Regarding these relations, it has to be taken into account that the present study measured the constructs simultaneously. This asks for a careful interpretation of the results. Although the data are consistent with the presented model, future research should incorporate time as variable to get a grip on the underlying processes and to validate the proposed conclusions. The quantitative methodologies used in the present research indicate the existence of the considered constructs and relations among them. A selection of qualitative approaches will be more capable to deliver insight into how and why relationships develop in team contexts (Keyton, 2000).

Prior research has demonstrated the impact of group size and group diversity on beliefs of the interpersonal context (Webber & Donahue, 2001). These variables are also likely to affect the difficulty groups experience in

creating mutually shared cognition. Future research should shed light on the impact of the composition of the groups on these processes.

Finally, this study focused only on groups of students in one educational context. It is conceivable that the tested relationships differ for different populations. The studied teams worked in a specific educational institution, and the conclusions are therefore not immediately transferable to completely different educational institutions. And although the task tackled by these teams is comparable to the task of some professional teams, this sample of students in an educational context may not be fully representative of professional work teams. Future studies in different contexts could strengthen the validity of the findings.

Note

1. Following Edmondson (1999) and van der Vegt, Emans, and van de Vliert (1998), we refer to beliefs as perceptions of reality by people.

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