

Patterns of Intellectual Collaboration and Effectiveness of Small Groups

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Abstract

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The present study examines the collaborative behaviors of 35 students of ages ranging from the mid-20s to early 40s (19 male and 16 female) enrolled in an intensive one-week graduate business course as they engaged in a competitive strategic decision-making simulation. Each group represented a firm. Their discourse in small groups of 3-4 was audio-recorded as they made a series of decisions over the course of the week.

The central research question is whether the analysis of audio recordings of small group interactions would reveal any cognitive features of the small group collaboration that would be predictive of a group's performance (measured by the final stock price of the group's firm at the end of the simulation). Discourse transcripts were analyzed using a relational and functional coding scheme that classified each utterance expressed during group interaction with respect to its function in relation to the utterance preceding it. Chosen for analysis was both an early and a late session since early tasks, such as establishing shared understandings, may entail different processes and patterns of interaction than later ones, such as reaching joint conclusions. Particular attention is focused on meta-level utterances, defined as those statements that reflect on the activity, rather than constituting a part of the activity itself and addressing the task subject matter. These meta-level statements are further divided into Meta-Self and Meta-Group categories, i.e., those statements that refer only to the self's thinking and those that refer to the

group. A hypothesis was that only Meta-Group statements would benefit coordinated action and hence, group performance.

The analysis focused on a comparison of the discourse characteristics of the highest and lowest performing groups. Results showed that members of the highest-performing group made significantly more Meta-Group utterances. In contrast, members of the lowest-performing group made more Meta-Self utterances, in proportion to total utterances made by each group. This difference was consistent across time. Examining the full sample of ten small groups, the pattern was similar. Results showed associations with performance outcomes for both of the discourse categories of major interest – most prominently for the frequency of Meta-Group utterances and to a lesser (and inverse) extent for Meta-Self utterances. The possibility is considered that Meta-Group discourse is productive because it represents a form of perspective-taking with respect to the group rather than the individual. Discussion of what the present data suggest about group process is supported by excerpts from individual post-course interviews and selected small-group discussions.

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Introduction

From little children's learning activities to adolescents' team projects, to adults' career tasks, collaboration can improve work outcomes. Many companies seek to understand what ingredients contribute to making teams work more effectively since strong is the foundation of influential companies. One five-year corporation-conducted study (Rovozsky, 2015) examined how variables such as group composition or motivation, affect team performance. These researchers had difficulty identifying patterns. However, group norms (Terry & Hogg, 1996) did appear related to group effectiveness. Moreover, more important than the identities of group members was the nature of the interactions among group members and how they viewed their contributions (Duhigg, 2016).

Researchers, as well as companies, have had a long-standing interest in the nature of collaborative problem-solving. Graesser and colleagues (Grasser, Foltz, Rosen, Shaffer, Forsyth, & Germany, 2018) point to the importance of learning skills of collaboration (Lai, Dicerbo, & Foltz, 2017), especially in light of increasing globalization (Cross, Rebele, & Grant, 2016). Studying patterns of interaction in collaboration offers a potentially rich body of information to researchers. However, this work is time-consuming, and existing research is insufficient.

To contribute to this research base, in the present study, we investigate group interaction and its relation to group effectiveness on the part of small groups of MBA students collaborating in a business simulation as a class assignment. Group discussions were audio-recorded, coded, and analyzed, with the objective of identifying dialogic patterns that would predict group success. Each group represented a firm in a competitive environment, and the group's success was measured by the final stock-price index of their firm's portfolio. In initial analyses, the audio-recorded group interactions at two time points were examined for two groups, the highest-

scoring group, and the lowest-scoring group and differences between the two groups in patterns of interaction were identified. In subsequent analyses, intermediate-performing groups were added to the report, to determine the extent to which this association between interaction patterns and performance generalized to the entire sample.

Chapter 1: Literature Review

1.1 Team Effectiveness and Team Cognition

A team is a set of two or more people who interact dynamically and interdependently toward a shared and valued objective (Salas, Dickinson, Converse, & Yannenbaum, 1992). In education research, small group collaboration shares the essential components of studies in teams – multiple individuals, interdependencies, and shared goals (Johnson & Johnson, 2008; Slavin, 1996). Group work leads to more effective problem-solving and learning outcomes than individualized work when certain features are present (Lai, Floyd, Hibbard, & Corter, 2016), as collaboration provides a context of “joint thinking” (Schwarz, 1995) through dialogue or argument (Cohen, 1994; Phelps & Damon, 1989). Similarly, in addition to encouraging undertaking work-related activities, teamwork plays a crucial role in a team becoming effective, which involves dynamic and episodic progress—encompassing the development of thoughts, feelings, and behaviors among team members while they interact toward a common goal (Salas et al., 1992; Salas, Shuffler, Thayer, Bedwell, & Lazzara, 2015). Barron (2003) suggested that the quality of cognitive and social interaction has implications for productive group work, as certain types of responses (acceptance, discussion) more often appear in relatively successful groups than their counterparts. Some studies (Webb & Mastergeorge, 2003; Chi, 2009) proposed constructive behavior during peer dialogue to positively influence learning outcomes. Findings from both field studies and lab research showed that effective group outcomes are dependent on the group’s prosocial motivation (Hu & Liden, 2015). Meta-analyses on team effectiveness ranged from examining social network structures (Balkundi & Harrison, 2006), team cohesion (Beal, Cohen, Burke, & McLendon, 2003), team types and settings (Chiocchio & Essiembre, 2009), relationship conflicts (De Dreu & Weingart, 2003), team diversity (Horwitz & Horwitz,

2007), information sharing (Mesmer-Magnus & DeChurch, 2009), and team cognition (DeChurch & Mesmer-Magnus, 2010) — to analyzing how teams moderated their work effectively.

Among the factors mentioned above, Salas et al. (2015) pointed to team cognition (Fiore & Salas, 2004) to be one of the critical considerations of teamwork and collaboration. Team cognition is defined as "a shared understanding among team members that are developed as a result of team member interactions (Klimoski & Mohammed, 1994) including knowledge of roles and responsibilities; team mission objective and norms; and familiarity with teammate knowledge, skills and abilities (Wildman, Thayer, Pavlas, Salas, Stewart, & Howse, 2012)." Team cognition serves as an essential foundation of teamwork and is strongly related to team process and team performance (DeChurch & Mesmer-Magnus, 2010). A review of 15 years of team cognition literature identified a variety of team-level outcomes that have been empirically investigated, including team norms, coordination, and team performance (Mohammed, Ferzandi, & Hamilton, 2010). It is clear that team cognition is vital for a variety of outcomes; less is known about the development of team cognition because of the difficulty of studying the phenomena. Though it is relatively simple to assess basic shared knowledge, it is substantially more difficult for researchers to measure and examine dynamic, moment-to-moment, shared understanding.

1.2 Collaborative and Metacognitive Discourse

The study of cognition as a collaborative process (Rogoff, 1998) examines how cognitive development occurs in a team and is promoted by individuals' collaboration with others. Behavioral lab studies demonstrate how groups of individuals interacting in real-time can self-organize into adaptive, problem-solving group structures. Cognitive processes may manifest as group-level behavior due to the interaction of multiple agents and their environment (Gureckis &

Goldstone, 2006). Collaborative discourse contains a mixture of arguments (Chinn, 2006; Felton & Kuhn, 2001), explanations (Webb 1991; Webb, Troper, & Fall, 1995), and a variety of other discursive activities (Chinn, O'Donnell, & Jinks, 2000). From a cognitive perspective, collaborative discourse is frequently thought to promote conceptual understanding.

Psychological research proposes socio-cognitive conflict and cognitive elaboration to be a general mechanism for attribution. However, more research is needed to discuss social and cognitive norms where participants interact — this is required just as crucial as an examination of metacognitive strategies implemented in the idea exchanges.

Metacognitive discourse is defined as discourse on the discourse itself, instead of the actual topic of the discourse. It is a subtle element during interaction and differentiates itself from discourse about the topic. It can be thought of as unwritten norms or group norms (Terry, Hogg, & White, 1999; Terry & Hogg, 1996) to govern how the discourse proceeds. Such meta-talk incorporates standards of evidence and argument, is shown to be a natural course in the dialogues (Kuhn, Zillmer, Crowell, & Zavala, 2013). The metatalk is shown to be associated with team effectiveness, as to increase achievement and motivation (Johnson & Johnson, 2004), to attribute group success (Barron, 2003), to enhance task-level performance (Grau & Whitebread, 2012), as well as to mediate group progress (Shaenfield, 2009). The meta-level talk is shown to evolve and be reciprocal (Zillmer, 2016), considered as a development process of such discourse. Education research to identify a specific feature needed to optimize collaborative problem-solving performance outcomes is metacognition, which in group work consists of planning and periodic checking to ensure strategies are executed appropriately (Graesser et al., 2018). Thus, it is worthwhile to investigate whether the discourse over time could be critical to understanding the development and formation of the meta-talk.

1.3 Group Coordination

Teamwork is fundamentally social, comprising communication, the exchange of ideas, and a shared identification of the problem and its elements. There are negotiated agreements on connections between the parts of the problem, tasks to accomplish, and potential solutions (Graesser et al., 2018). Effective coordination is a primary driver for positive teamwork and collaboration outcomes (Salas et al. 2015). Coordination includes synchronization and integration of group activities to accomplish the task in a timely fashion (Graesser et al. 2018); it encompasses behavioral mechanisms necessary to perform the task and transform group resources into outcomes (Sims & Salas, 2007). Studies found the utilization of routines to distribute responsibilities to have a positive impact on group effectiveness (Gersick & Hackman, 1990; Weick & Roberts, 1993). A meta-analysis by Stewart (2006) supported that within-team coordination corresponded with higher team performance.

Diversity is valued (Page, 2010) to correspond to the group's effectiveness because of the product of disagreement and contest, not consensus or compromise to spark the ideas. Only by asking people to make sense of a task together, they are faced with challenges of establishing common frames of reference, resolving discrepancies in understanding, negotiating issues of individual and collective action, and coming to mutual agreement (Miyake, 1986; Roschelle, 1992). For convergence to occur, team members have to orient themselves to engage in coordinated activities, where coordination is fundamental for the establishment of mutual knowledge or common ground (Barron, 2000). Coordination involves the use of team-level strategies to align knowledge and actions to achieve common goals (Arrow, McGrath, & Berdahl, 2000; Brannick, Prince, Prince, & Salas, 1995).

Through interaction analysis, the analysis can illuminate the process of coordinating can be hindered or achieved. The study showed how to differentiate two groups' performance by the degree of coordination among the group members (Barron, 2000). The criteria for comparison are the degree of mutuality in interaction, the extent to which there was a joint focus of attention, and the level of salient, shared task alignment that arises during the interaction (Barron, 2000). Findings from Roschelle's utterance analysis (1992) demonstrates that collaborative effort in a group-coordinated conversation can unify the group's understanding. Utterances are recognized as displays of knowledge because of their precise placement in the sequence and situation of activity. Thus, through interaction analysis, the aspect of coordination can be investigated in a finely detailed manner.

1.4 Group Characteristics

Group characteristics have been shown to affect group performance (Hong & Page, 2004). To predict group performance, Woolley et al. (2000) measured the average social sensitivity of group members, the equality in distribution of conversational turn-taking, and the proportion of females in the group. While a higher percentage of females in a group could be positively related to group performance (Woolley et al., 2000), studies showed diverse gender composition contributing to better group outcomes (Apesteguia & Iriberrri, 2012; Hoogendoorn, Oosterbeek, & Van Praag, 2013). Diversity in a group of people in these studies refers to differences in the individuals' demographic characteristics, cultural identities and ethnicity, and their training and expertise (Hong & Page, 2004). Studying group performance over time, Harrison, Price & Bell (1998) proposed that psychological diversity has more impact on group performance than demographic diversity. Other studies have found that frequently collaborating on tasks could also reduce the effects of demographic differences (Elsass & Graves, 1997; Harrison et al., 1998). In

the study of Hong and Page (2001), diversity was defined as differences in processing problems internally or individuals' perspectives that lead to optimal outcomes. Hong and Page also found groups of diverse problem solvers outperformed groups of high-ability problem solvers. Kilduff, Angelmar, and Mehra (2000) also supported cognitive diversity as playing a role in predicting group performance. The attempts to measure diversity are mainly through self-reported survey questions, as Kilduff et al. (2000) adopted Zucker's (1977) cognitive-variable constructs for cognitive diversity, while Hong and Page (2001) used performance to match agents' diversity percentage. Most diversity indicators focus on self-reported or perceivable variables outside of the context of collaboration. Little is known about the psychological diversity by observing actual, interactional discourse—which our study is devoted to understanding through transcribing, coding, and categorizing utterances.

1.5 Group Engagement

In addition to cognitive aspects of group work studies, social cognition is an approach to understanding human social behavior, involving investigating the process of interaction (Martin & Clark, 1990). The group engagement model expands to identify a procedural method essential to shaping members' social identity within groups, and in turn, influences attitudes, values, and behaviors (Tyler & Blader, 2003). Glazer and his colleagues (Glazer, Steckel, & Winer, 1989) showed that groups with a more positive attitude toward the task of marketing decision-making perform better. Furthermore, the role of socio-emotion (Barry & Stewart, 1997) in groups could hinder or facilitate group performance when a group with positive moods outperformed its opposite (Hayashi, 2018; Heerdink et al., 2013). Group members engaging in productive communication is crucial for teamwork. Studies include inquiring about others' goals and interests and soliciting input from everyone (Stevens & Campion, 1994); providing planning and

coordinating statements (Ellis, Bell, Ployhart, Hollenbeck, & Ilgen, 2005); showing openness in modifying one's position to recognize other members' arguments (Chen, Donahue, & Klimoski, 2004); acknowledging teammates (Achille, Schulze, & Schmidt-Nielsen, 1995); asking for help or giving help (Hu & Liden, 2015); and engaging in small talk (Stevens & Campion, 1994).

Groups are vehicles for patterning interaction. However, the analysis of the behaviors in a team setting is complex. The analyses require coding communication behaviors that are quite time-consuming and resource-intensive. The recent development in automated text-analysis tools provides a means of monitoring a group's work process. However, it has its limitations in accuracy and measuring a team's discourse collective contributions. To better understand the socio-cognitive aspect of a group's process, researchers might consider starting with smaller data and then extending the scope of work to utilize the automated analyses.

1.6 Marketing Strategy Simulation

The potential power of computer-supported learning has been well-documented, as has the potential of peer collaboration as a learning tool (Faria, 2006). Computer simulations of business environments have been in use for several decades in the education of graduate-level students in business schools around the world (Bach, Zoroja, & Fašnik, 2017). In the present study, the particular simulation is Markstrat. It was developed by Jean-Claude Larrache and Hubert Gatignon at the international business school Insead in Fontainebleau France in the late 1970s and has since been regularly updated. Thousands of students in regular and executive MBA programs have used Markstrat as the core component of a course in marketing strategy in business schools in Europe, the Mid-East, Asia, North America, and Latin America. Markstrat is the world leader in marketing management simulation games, and it meets the pedagogical quality criteria (Cook & Swift, 2006). During the simulation environment, several teams,

consisting of participating students, compete against each other in an artificially-designed market setting. Each team manages a company with an existing product portfolio, launch new products, implement decisions on R&D, production planning, size of the commercial team, manufacturing, pricing, advertising, and distribution, within the allocated budget. The simulation progresses through a series of decision periods, with a cyclical process that the team analyzes the competitive environment at the beginning of each period and submit decision, considering the strategic objectives and the competitive evolution of the company. The proposed decisions by all teams are then used to simulate to return subsequent results to the teams, representing the starting point of a new decision period. The team performance is the Stock Price Index (SPI) of the company to determine the growth in returns to shareholders (Gatignon, 1987). The goal of the simulation is to maximize the Stock Price Index (SPI), which considers several indicators, including net contribution generated, product market share, growth of revenues, and the quality of projects completed. Markstrat leads to a better understanding of marketing management concepts (Anderson & Lawton, 2009). Despite the simplification of the simulated environment, the processes reproduce the responsibilities of a real-life marketing leader working under pressure to implement the strategic organizational decision. Findings show that Markstrat is useful in developing marketing decision-making capabilities in complex and dynamic situations (Pasin & Giroux, 2011).

Chapter 2: Method

2.1 Participants

Participants were 35 students (16 females) in an Executive MBA (EMBA) program in the business school of a major urban university in the Northeast United States. All participants were enrolled in a capstone marketing strategy course designed for both EMBA and full-time MBA students. Most of the students had prior experience as practicing managers or entrepreneurs in the business or non-profit world, and the vast majority continued their professional employment while attending the program part-time. All held at least a bachelor's degree, and many had earned other post-graduate degrees before entering the EMBA program. Their ages ranged from the mid-20s to early 40s. They were randomly assigned to ten groups of three to four persons to perform a strategic marketing decision-making simulation jointly. At least one female student was in each group. Five groups were composed of four persons, and five had three persons.

2.2 Procedure

The major component of the course was the Markstrat (Larreche & Gatignon, 1977) simulation activity. In the simulation, each randomly-assigned student team of three or four represents a firm that competes against four other firms in its industry (represented by other student teams). The present group operated on only one sector. However, the simulation can allow course groups to operate in multiple industries. The starting positions of firms (teams) are different, but all firms are roughly equivalent in terms of strengths, weaknesses, opportunities, and threats. Each firm makes decisions over eight periods (equivalent to business years). Each firm secures marketing research data, assesses likely competitor reactions to its potential moves, and makes marketing decisions – strategic and implementation. Because the simulation extends across eight periods, teams can measure results – sales, market share, profit contribution, share

price – that follow from their decisions, and accordingly evolve objectives, strategies, and implementation plans from period to period.

At the beginning of the course, each student gave signed consent (Appendix A) to having their small-group discussion sessions audio-recorded for research purposes. During eight periods of decision-making, groups accomplished one or two decisions each day across the five full days that constituted the duration of the course. The time groups took to examine the last period's results, collaborate, and make new decisions varied across the eight periods. On average, groups spent 1.5 hours of discussion per period. Once the simulation concluded, each group prepared a class presentation intended to address objectives, strategies, implementation programs, and performance and to identify key lessons learned. Presentations were graded and contributed to the final course grade.

The course instructor made available to the researchers each team's score on the key performance variable, the final stock price index (SPI) that the team's firm had attained by the end of the simulation. An index of 2000 or higher reflects strong performance, while scores of 1500 or below reflect weak performance. Other measures of a firm's final performance exist, but because these were highly correlated with SPI, only SPI is used in the present analysis.

Chapter 3: Results

Given the exploratory nature of this research, we sought to identify differences in group processes associated with stronger and weaker performance outcomes. For this purpose, we chose for an initial comparison of the highest performing of the ten small groups (defined by SPI) and the lowest-performing group. For each of these two groups, two early group sessions (Periods 1 and 2) and two later group sessions (Periods 7 and 8) were examined.

3.1 Coding of Group Sessions

To analyze transcripts of group interaction during these sessions, we applied a coding scheme established by one of the authors and colleagues for classifying dialogic moves in argumentative discourse. This scheme was developed by one of the authors and colleagues and has been used in numerous previous studies on argumentation (see Rapanta, Garcia-Mila, & Gilabert, 2013). Classification is based on the function of an utterance with the utterance immediately preceding it. Our rationale for employing this scheme is the anticipation that it is this relational function that is key to the coordinated action central to the group process.

Coding categories appear in Table 1. A crucial distinction the coding scheme makes is that between statements addressing the subject matter and meta-level statements referring to the discourse itself. In the present study, meta-talk categories are further divided into meta-talk about the speaker him/herself ("Meta-Self") and meta-talk referring to one or more members of the group or the group as a whole ("Meta-Group").

Transcripts were segmented into idea units and coded blind to group, individual speaking, and period. A total of 1783 units (16% of the entire database) were coded independently by an author and another blind coder to establish coding reliability. Independent coding by the two trained coders was above 90% for segmenting (Cohen's kappa, $\kappa = .947$), and above 80% for

assignment to category (Cohen's kappa, $\kappa = .805$). Differences were resolved by discussion, and the author performed the remaining coding.

Table 1: The coding scheme for group discussion

Meta-Talk	Definition	Sample utterances
Meta-Self	An utterance that relates to self, rather than the subject matter of the discussion	"I am very concerned about what the R&D portfolio is." "It just does not make sense to me."
Meta-Group	An utterance that relates to the group's discussion itself, rather than the subject matter of the discussion	"And we see, the feasibility and the R&D." "Because of the question we need to answer for the research part."
Topic-Talk	Definition	Sample utterance
Add	Topic talk, non-substantive task talk, status update talk	"So, in terms of Vodites."
Agree?	A question asking whether the partner will accept or agree with a claim	"Do you want to keep the base cost the same?"
Agree	A statement of agreement with the partner's immediately preceding assertion	"Yes, that is what I thought."
Claim	An utterance to state or to assert something	"Cause it is showing this is from the production design."

Clarify?	A request for the partner to clarify his or her proximal utterance	"Okay, you are not doing R&D and stuff, right?"
Clarify	A clarification of the speaker's position or argument in response to the partner's immediately preceding utterance	"Yeah, we need to focus on branding."
Counter	A disagreement with the partner's immediately preceding utterance	"No, last time was 1500."
Cut Off	An utterance of stopping or interrupting	"But wait."
Strategy-Suggestion	An utterance to suggest a strategy	"We can also introduce Sonite; we have high earners and professionals."
Question	A simple information query which does not refer back to the partner's proximal utterance	"How do you define perceptual message?"

3.2 Comparison of Highest and Lowest Performing Groups

As seen in Tables 2 and 3, the most top-performing and lowest performing groups differed markedly at all four periods examined with respect to the duration of the discussion for that period and the number of idea units it contained, with the longer durations and larger number of idea units shown by the highest performing group in all cases. As a result, category usage is examined by proportion rather than only frequency.

Table 2: Discourse time of the highest and lowest performing groups

Group	PERIOD 1 (Minutes)	PERIOD 2 (Minutes)	PERIOD 7 (Minutes)	PERIOD 8 (Minutes)
Highest-Performing	120	163	99	73
Lowest-Performing	96	64	58	40
Average Discussion Time of All Ten Groups	102.3 (<i>SD</i> = 16.7)	116.1 (<i>SD</i> = 30.8)	62 (<i>SD</i> = 29.6)	51.3 (<i>SD</i> = 26.6)

Table 3: Idea units produced by the highest and lowest performing groups

Performance	PERIOD 1 (Units)	PERIOD 2 (Units)	PERIOD 7 (Units)	PERIOD 8 (Units)
Highest-Performing	1068	1137	955	781
Lowest-Performing	773	646	305	341

The proportion of usage of each of the discourse types by the highest and lowest performing groups are presented in the following tables, for each of the four decision periods examined (Tables 4 through 7) and in summary form across all four periods (Table 8). At each period, the difference between the highest- and lowest-performing groups in the proportion of utterances that are of each coded type was tested with a chi-square test of homogeneity. Because the twelve coding categories cannot be assumed to be independent of each other, a Bonferroni adjustment was used to hold the overall alpha level at or below .05 (adjusted alpha = $.05/12 = .004$). Note

that because utterances (observations) too cannot be assumed independent of each other, the validity of the chi-square tests can best justify as a permutation test (Freedman & Lane, 1983).

As summarized in Table 8, the two Meta categories (Meta-Group and Meta-Self) are the only categories to distinguish the highest and lowest performing groups consistently, with the association in opposite directions for the two categories. The Agree, Agree Question, and Counter categories distinguish the groups at more than one period, but neither does so consistently (Table 8).

Table 4: Decision period 1 proportion usage of discourse types by the highest and lowest performing groups

Meta-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Meta-Self	8.1%	15.8%	34.21	< .0001*	.004
Meta-Group	16.2%	8.2%	33.69	< .0001*	.004
Topic-Talk	Highest-Performing	Lowest-Performing	χ^2 (df =1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Add	7.7%	6.9%	0.51	0.4768	.004
Agree?	2.7%	1.8%	1.30	0.2538	.004
Agree	25%	15.9%	37.18	< .0001*	.004
Claim	15.5%	17.6%	1.87	0.1712	.004
Clarify?	6.6%	6.6%	< .01	1.0000	.004
Clarify	4.8%	6.0%	1.15	0.2831	.004

Counter	1.4%	5.3%	23.43	< .0001*	.004
Cut Off	0.9%	3.6%	15.43	< .0001*	.004
Strategy-Suggestion	7.9%	7.2%	0.20	0.6535	.004
Question	3.1%	5.2%	5.02	0.0251	.004

Note: Effective Ns are presented in Table 3. During decision 1 round, the highest performing group produced 1068 idea units, while the lowest group produced 773 idea units.

Table 5: Decision period 2 proportion usage of discourse types by the highest and lowest performing groups

Meta-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Meta-Self	2.5%	10.7%	60.56	< .0001*	.004
Meta-Group	18.6%	7.1%	58.35	< .0001*	.004
Topic-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Add	5.8%	6.7%	0.45	0.5042	.004
Agree?	0.4%	2.0%	10.6	0.0011*	.004
Agree	15.6%	12.1%	5.35	0.0207	.004
Claim	20.8%	18.3%	2.44	0.1184	.004
Clarify?	4.7%	8.5%	11.65	0.0006*	.004
Clarify	3.8%	5.7%	3.56	0.0593	.004
Counter	4.1%	3.7%	0.11	0.7440	.004

Cut Off	0.4%	1.9%	7.52	0.0061	.004
Strategy-Suggestion	12.5%	15.8%	4.96	0.0260	.004
Question	11.0%	7.6%	6.26	0.0123	.004

Note: Effective Ns are presented in Table 3. During decision 2 round, the highest performing group produced 1137 idea units, while the lowest group produced 646 idea units.

Table 6: Decision period 7 proportion usage of discourse types by the highest and lowest performing groups

Meta-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Meta-Self	4.9%	15.1%	41.82	< .0001*	.004
Meta-Group	30.0%	10.8%	63.33	< .0001*	.004
Topic-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Add	9.0%	13.8%	6.83	0.0090	.004
Agree?	0.4%	1.3%	1.71	0.1907	.004
Agree	10.8%	8.2%	1.80	0.1802	.004
Claim	16.5%	19.0%	1.32	0.2502	.004
Clarify?	5.7%	6.9%	0.50	0.4803	.004
Clarify	4.1%	5.6%	0.99	0.3193	.004
Counter	4.4%	3.3%	0.53	0.4681	.004
Cut Off	0.6%	1.3%	0.66	0.4174	.004
Strategy-Suggestion	7.5%	8.5%	0.24	0.6264	.004

Question	8.1%	6.2%	1.02	0.3117	.004
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Note: Effective Ns are presented in Table 3. During decision 7 round, the highest performing group produced 955 idea units, while the lowest group produced 305 idea units.

Table 7: Decision period 8 proportion usage of discourse types by the highest and lowest performing groups

Meta-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Meta-Self	7.0%	11.4%	6.69	0.0097	.004
Meta-Group	19.3%	9.1%	25.08	< .0001*	.004
Topic-Talk	Highest-Performing	Lowest-Performing	χ^2 (df = 1)	<i>p-value</i>	<i>Bonferroni adjusted alpha</i>
Add	10.2%	9.4%	0.15	0.7010	.004
Agree?	5.0%	1.2%	8.99	0.0027*	.004
Agree	23.7%	13.8%	22.38	< .0001*	.004
Claim	12.5%	18.5%	9.20	0.0024*	.004
Clarify?	6.4%	8.8%	2.04	0.1528	.004
Clarify	5.2%	4.4%	0.23	0.6281	.004
Counter	0.9%	5.9%	24.6	< .0001*	.004
Cut Off	0.5%	2.3%	6.10	0.0135	.004
Strategy-Suggestion	4.9%	12.0%	21.12	< .0001*	.004
Question	4.2%	3.2%	0.43	0.5107	.004

Note: Effective Ns are presented in Table 4. During decision 8 round, the highest performing group produced 781 idea units, while the lowest group produced 341 idea units.

Table 8: Discourse categories distinguishing highest and lowest performing groups for decision periods 1, 2, 7 & 8 combined

Meta-Talk	PERIOD 1	PERIOD 2	PERIOD 7	<i>PERIOD 8</i>
Meta-Self	–	–	–	
Meta-Group	+	+	+	+
Topic-Talk	PERIOD 1	PERIOD 2	PERIOD 7	<i>PERIOD 8</i>
Agree?		–		+
Agree	+			+
Clarify?		–		
Claim				–
Counter	–			–
Cut Off	–			
Strategy-Suggestion				–

3.3 Patterns of Intermediate Performing Groups

Given the converging evidence regarding the differential use of meta-level discourse categories between highest- and lowest-performing groups, in subsequent analysis. We examined the extent to which this pattern would hold among the full sample when middle-level-performing groups were included. We thus randomly selected 10-minute segments of each of the ten groups' discussion for Periods 2 and 7 (to represent early and late stages of decision cycle) to investigate the association between a groups' category usage during the discussion and group performance. For period 2, the mean discussion time was 116.1 min (range 64-163). For period

7, mean discussion time was 62 min (range 14-113) – both means intermediate between the times for the lowest and the highest performing groups for these respective periods. With the duration of randomly selected segments of sessions, 2 and 7 held constant at 10 min, there was not a great range in the number of idea units within the 10 min segments, with a range across groups from 99-204 for period 2 and a similar range of 95-198 for Period 7.

Results showed associations with performance outcomes for two of these discourse categories, most prominently for the Meta-group and to a lesser extent, the Meta-Self categories. Qualitative inspection reveals the highest three performing groups (on final SPI) all showed a combined (periods 2 and 7) frequency of Meta-group idea units of greater than 40. By comparison, of the remaining seven groups, less than half (3 of 7) reached a frequency of 40 (Appendix I & J). Correspondingly all three of these highest performing groups are among the four highest Meta-group users at period 2 (though not period 7). Chapter 4: Name of the Fourth Chapter

3.4 Correlation between Utterance Category and Group Performance

In initial analyses, the audio-recorded group interactions at two time points were examined for two groups, the highest-scoring group and the lowest-scoring group and differences between the two groups in patterns of interaction were identified. Here we added intermediate-performing groups to the analysis to determine the extent to which this association between interaction patterns and performance generalized to the entire sample.

Quantitative treatment of these data yields correlation coefficients of .76 for Period 2 and .70 for Period 7 between proportions of Meta-Group usage and groups' final SPI performance score. In contrast, the correlation between Meta-Self proportion and performance is negative, a -.76 for Period 7 and nonsignificant -.45 for Period 2. The small number of cases, however, means that

these correlations must be treated only as suggestive. No other correlations between discourse categories and performance achieved significance.

The patterns across groups for the Meta-Group and Meta-Self data are shown in Figure 1 for the Meta-Group category, and Figure 2 for the Meta-Self category. Also worthy of note in these figures is the fact that incidence is fairly stable across the two periods, at least for nine of the ten groups, suggesting that these are relatively stable characteristics of a group across time. Also, finally, as seen in Figure 1, Meta-Group incidence increases over time among the majority of groups, suggesting that most groups are increasing their intra-group coordination over time. For each line, it represents the change of a group's proportion of utterance discourse category usage from period 2 to period 7. Red is for the highest group (the highest SPI), blue is for the middle groups, and green is for the lowest group (the lowest SPI).

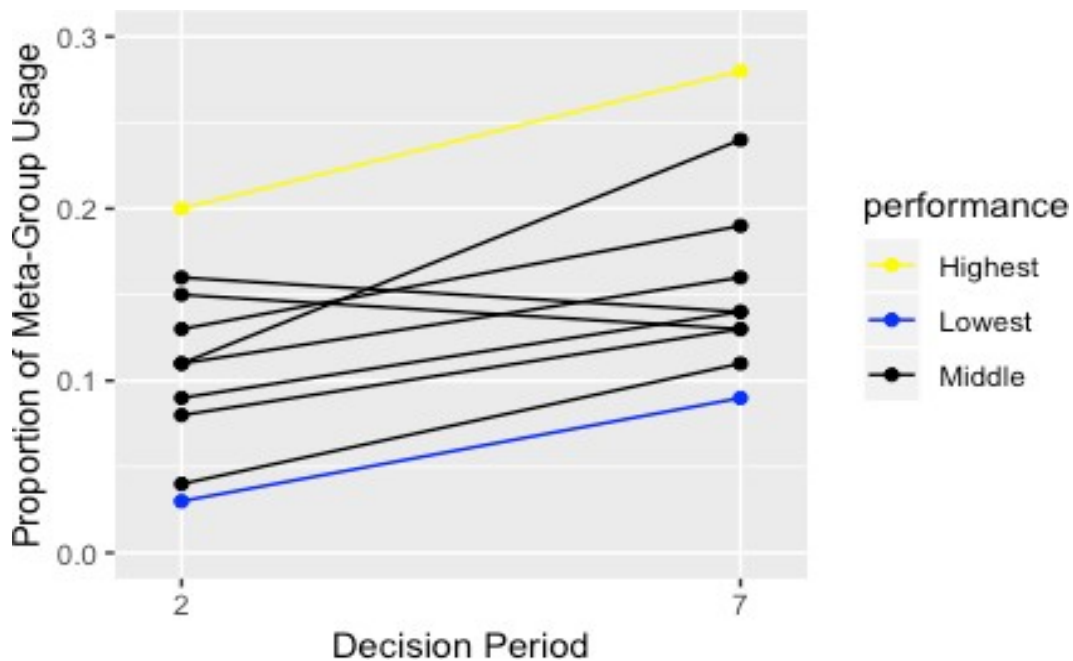


Figure 1: Meta-Group discourse proportions by group performance for periods 2 & 7.

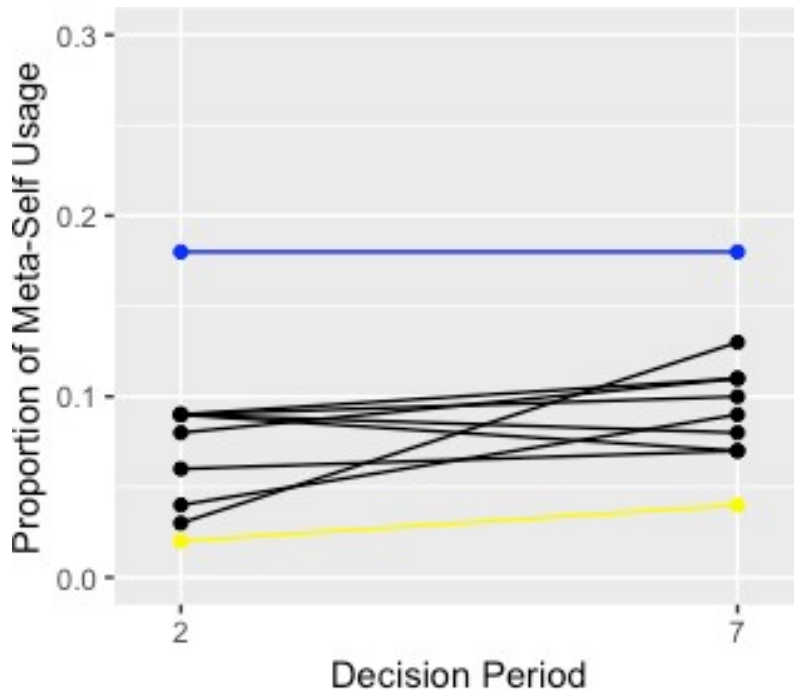


Figure 2: Meta-Self discourse proportions by group performance for periods 2 & 7.

Chapter 4: Discussion

4.1 Summary of Findings

In our study, the audio recordings of small-group interactions showed cognitive features of the small-group collaboration to differentiate the groups' performance. The differences in usage of metatalk, referring to group or self, corresponded to the highest- and lowest-scoring groups. The highest-performing group demonstrated a consistently higher proportion of Meta-Group category usage during their group discussion, while the lowest-scoring group's dialogue contained a higher proportion of Meta-Self utterances. Furthermore, this pattern appeared in the overall sample of ten groups, most prominently for the Meta-Group usage, and to a lesser extent in the Meta-Self category. Meta-Group utterance is defined as an utterance that relates to the group's discussion itself, rather than the subject matter of the discussion. In other words, such utterance is considered from the perspective of the group. On the other hand, the Meta-Self utterance is focused more on the perspective of an individual. One may argue that Meta-Group utterance is essential in a team setting because of team cognition, as the Meta-Group utterance captures the concept of a shared understanding among members (Fiore & Salas, 2004). In order to further understand the role Meta-Group utterance plays in groups' interactions, we studied excerpts of the highest- and lowest-scoring groups to compare the formation and development of their collaboration and teamwork — to identify subtle differences of metatalk usage during the interaction.

4.2 Group Coordination

The quality of interaction within a group is a crucial component for successful small-group collaboration (Leyland et al., 1994; Curren et al., 1992). Studies (Littleton & Mercer, 2013; Lefstein, 2010) have shown the potentially valuable role of metatalk in group interaction.

Specifically, meta-communication (Dillenbourg & Traum, 1999) aims for group coordination, involving mechanisms like regulation or planning (Kwon et al., 2013; Gouran et al., 2009; Zillmer, & Kuhn, 2018). In our study, a pattern of Meta-Group utterance increasing over time among the majority of groups developed, which suggests that most groups are improving their coordination over time. While the highest-performing group showed significantly more Meta-Group usage during group interaction than the lowest-performing group, the coordination of group work can be attributed to regulation or planning. In the marketing decision-making simulation, each group started with equal performance status. The decision-making task itself was complicated for a single individual to accomplish, given a constraint time. In period 1, episodes from the highest- and lowest-performing groups showed different approaches to the task. While the highest-performing group opened their collaboration with spending some time on digesting the materials, and then came together to share insights, the lowest-performing group jumped into the decision making itself, even with many questions left to be solved.

Data (utterances in period 1 from the lowest-performing group)

- | | | | |
|----|---|---|-----------|
| 1. | B | Okay, I am on the homepage. | Meta-Self |
| 2. | B | So, right now, we have to go to a decision review, right? | Clarify? |
| 3. | C | I am just looking at the decisions. | Meta-Self |
| 4. | C | What is our team name? | Clarify? |
| 5. | A | So, we have to . . . Yeah, I think we will create one, right? | Clarify? |

Data (utterances in period 1 from the highest-performing group)

1. A First, to start is that we can do a couple of things. Meta-Group
2. A We can start by reading some of the information to make sense of . . . Meta-Group
3. B Sure Agree
4. A What do you guys think? Meta-Group
5. A Do you want to take 10 to 15 minutes to consume the materials, and then we can all decide the strategy? Meta-Group

Such coordination may not be easily achieved when people gather together without knowing each other in the first place. Excerpts below show that in the highest-performing group, one member took the lead to suggest distributing the task according to each individual's strength and background.

Data (utterances in period 1 from the highest-performing group)

191. A Is there anyone, because of their experience, has just there? Question
192. A Just interest, strong preference, like personality to communicate about? Question
193. C Yeah, I have good experience in the marketing segment strategy. Claim
-
207. A We can have ten sheets, for instance, between research and advertisement, and something like that. Strategy-Suggestion
208. B Umm Agree

209.	A	So, probably we will need for that CFO and then maybe an organization like keeping people on time, pushing for the decisions.	Strategy-Suggestion

214.	A	Profile picture and coordination, maybe.	Add
215	C	Yeah, financial picture and coordination.	Agree
216	A	Cool, anyone else has international information percentage?	Question
217	D	Umm, I am more [interested in] internationalization.	Claim
218	A	Okay	Agree
219	D	And, also the communication, this is where I can really have. . .	Claim

By examining the group interaction, we could see that in addition to the group coordination, leadership in a group played a pivotal role in determining a group's final performance. The leader of the highest-performing group contributed 35–51% of Meta-Group usage across periods 1, 2, 7, and 8. However, there was not an individual in the lowest-performing group who contributed consistently to the Meta-Group utterance. The findings of group coordination and leadership can also be supported by our interview with a member of the highest-performing group.

“Moreover, I think that was the main reason that pushed our group to work better. Also, to make good results. Cause the way we are communicating with each other that tried to divide the task differently, and of course, we had a good task division, we are covering mainly all fields we had to cover and then we were like to win first.”

“Yeah, so that is what we discovered there. We were in the meeting there and for the first time. Oh, you are in the field of communication, why don't you handle this, why don't you handle that since you have experience in this.”

“So, when I want to tell you that one group member, I don't remember her/his name. She/he took the initiative of guiding the group, you know. She/he was the most experienced one, I think, and she/he said why we don't divide the task. And she/he was on the board, writing notes and dividing the task and from the first round, we decided to give each task to each person, and that is what we followed, actually. It is the same rule for each person on each task. Obviously, it is too much work; that's why we divided the task. Second, because what we know discovered after meeting each other, each person, even me, who is not in the field of marketing or finance, so even me, they had a chance to benefit from communication background. So, they gave the advertising related task, advertising marketing, so read the reports related to these. For the person you know in analytics and the other in international marketing, so that is how we divided the tasks, based on our experiences.”

4.3 Group Characteristics

The makeup of a group is essential in terms of group success (Woolley et al., 2000). Prior studies implemented in a marketing simulation context showed that gender diversity (Apesteguia & Iriberry, 2012; Hoogendoorn et al., 2013) and cognitive diversity (Kilduff et al., 2000) play a role in predicting team performance. In this present study, the proportion of females in the group did not show a significant correlation with final group performance ($r = -.271$, $p\text{-value} = .45$). However, it was the metatalk to distinct group outcomes. The group characteristics of uttering more meta-group dialogues are shown relationship with the final stock price index (SPI). The episode shows the first five audio-recorded utterances at an early stage (period 2) of discussion from the lowest-performing groups. One may see the initiation of the conversation started with the metatalk about the speaker himself/herself.

In comparison, the highest-performing group started with a warm-up discussion of setting up the laptop for all group members to share the screen. They then had a smooth transition to reviewing the group reports, where they situated each other in the same context of group performance review. Meanwhile, from the beginning of the utterances, more Meta-Group statement was used, referring to one or more members of the group or the group as a whole. Similarly, more usage of Meta-Self utterance appeared in the low-performance group at a later stage of the decision cycle, which was less likely to appear at all in the best-performing group.

Data (first five utterances in period 2 from the lowest-performing group)

1. B Right now, I am just comparing brand awareness for each segment. Meta-Self
2. B I am hoping this will tell us where we spend dollars on the market next. Meta-Self
3. A Okay Agree

- | | | |
|------|--|-----------|
| 4. C | I feel there are other products. | Meta-Self |
| 5. C | Competitors' products are much better suited for other segments. | Claim |

Data (first five utterances in period 2 from the highest-performing group)

- | | | |
|------|---|------------|
| 1. A | Okay, so let's come back to the dashboard. | Meta-Group |
| 2. A | Quickly, so, we increased the market share, our stock went up | Meta-Group |
| 3. C | So, this is the cumulative market share? | Clarify? |
| 4. B | Yes | Clarify |
| 5. C | Total market-share. Dollars are up 30% — that is good too. | Add |

Period 7 discourse data from the first five utterances showed that the lowest group shifted gear to other assignments, rather than the marketing decision making. A possible explanation is that the nature of the competitive marketing simulation, there was less likelihood for a second chance, as their group performance (SPI) decreased over time. On the contrary, the audio-recorded data showed the highest-performing group began their discussion by examining their production and demands of the product, in which they continued focusing on the progress and brought the decisions to be made on the table for a shared understanding.

Data (first five utterances in period 7 from the lowest-performing group)

- | | | |
|------|---|------------|
| 1. C | So, I am going to finish up the assignment. . . | Meta-Self |
| 2. C | I have a good start to the presentation. | Meta-Self |
| 3. C | So, you guys are, okay you, can make all the decisions. | Meta-Group |
| 4. A | Yeah, yeah, no problem at all. | Agree |
| 5. C | I feel this is like crazy. | Meta-Self |

Data (first five utterances in period 7 from the highest-performing group)

- | | | |
|------|---|------------|
| 1. A | Yeah, so, we sold out [brand], we produced 400. | Meta-Group |
| 2. A | Also, there is a demand for or so more [brand] is made. | Claim |
| 3. C | How many units did we put for [brand]? | Clarify? |
| 4. A | I think 50% or something. | Clarify |
| 5. B | [assignment due] at 9 p.m. | Cut Off |

4.4 Group Engagement

The utterance category Meta-Group is metatalk, referring to one or more members of the group or the group as a whole. Such utterance has the potential to moderate group engagement since it may induce shared understanding, interdependence, and lead to a common goal. Meta-Group utterance could provoke a positive emotion to demonstrate inclusion. Glazer and his colleagues (Glazer et al., 1987) showed that groups with a more positive attitude toward the task of marketing decision making perform better. Moreover, Barry & Stewart (1997) demonstrated that the role of socio-emotion in groups hindered or facilitated group performance when a group with positive mood outperformed its opposite (Hayashi, 2018; Heerdink et al., 2013). Throughout the periods, the members of the highest-performing group demonstrated enjoyment and held a positive attitude toward the group work. The excerpts of the interview and group dialogues below could provide a glimpse of their engagement.

“You know we were like pumping a lot of energy, hard work, toward one main objective. Also, you know this objective changed from round to round. However, the main objective was to be like first, you know, won the

competition, but on each round, we fixed a new objective, like creating a new product, launching a new product, stopping a product, you know, paralyzing and keeping it until it dies.”

Data (utterances in period 8 from the highest-performing group)

953.	C	We are done.	Meta-Group
954.	A	Guys, it has been a pleasure.	Meta-Group
955.	B	Oh yes, we are not done yet, we still have a presentation.	Claim
956	C	Yeah	Agree
957	B	All our secrets	Meta-Group
958	C	It is a fun course, right?	Agree?
959	B	Yeah	Agree

4.5 Theoretical Implications

The findings of the Meta-Group utterance, contributing to small-group effectiveness, add to the body of team cognition research. Members of compatible backgrounds and management experience worked together as a team of three or four with an equal starting point of marketing share. The development of the group dialogues brought groups to divergent effectiveness. Team cognition is essential to a variety of outcomes; our study pinpoints dynamic, moment-to-moment, shared understanding through interaction analysis to shed some light on the area. Reflecting the cooperative learning research (Johnson & Johnson, 2009), interdependence and a particular kind of decentralization are conditions that are necessary for the group to be effective. Meta-Group dialogue situates group members to sense the group awareness needed to achieve the group goal.

Some of the findings, such as the importance of leadership and attention to the thinking of others, have been suggested in previous literature on group process (Duhigg, 2016; Hogan et al., 2014; Graesser et al., 2018). Much of the existing empirical research relies on automated or members' self-report regarding group process. The present study thus contributes to supporting such findings when the group process is studied directly.

4.6 Practical Implications

A call for teamwork in the workplace has become vital for employees, and it is as critical within the organization as well as outside. From our findings, meta-level discourse makes an essential contribution to the success of the collaboration. However, to play this role, the meta-level discussion must refer to the group and not merely to the individual to make this statement. Meta-Group dialogue serves to regulate or monitor group conversation to center a group perspective, rather than personal or individual awareness. Corporation-conducted research to understand what factors contribute to team effectiveness pointed to crucial dynamics, including psychological safety, dependability, structure, clarity, the meaning of work, and impact of work (Rovozsky, 2015). The description of each item started with considering acting as a group. Specifically, critical dynamics identified in the corporation-conducted research are defined as “can we take risks on this team?”, “can we count on each other . . .”, “are roles, goals . . . on our team clear,” from the Meta-Group perspective. For a member to show her/his authority, the goal is to bring her/his best to reach the group goal. Our study to find the importance of Meta-Group dialogue echoes to the findings from the corporation-conducted research. New and challenging real-world problems are most often confronted collaboratively. That is also the main reason the corporation would invest in understanding the mechanisms of productive collaboration. Our study identifies and illustrates respects in which individual meta-level representations of what the group needs to do, is doing, or

has done are expressed and thereby shared with other members of the group. The findings support the view that this sharing is facilitative to achieve coordinated action that is required. Thus, it is essential that when we consider productive collaborative in the workplace, it is to bring perspectives or awareness to think as a team to impact team effectiveness.

4.7 Educational Implications

This paper addresses an area of some importance to investigate what are the indicators of productive collaboration for adult learners, specifically those in MBA classes that use collaborative, project-based learning. Education research has identified metacognition as a specific feature needed to optimize collaborative problem-solving performance outcomes, which in group work consists of planning and periodic checking to ensure strategies are executed appropriately (Graesser et al., 2018). Yet we are only beginning to make progress in determining what makes collaborative problem solving effective (Graesser et al., 2018), and the boundary conditions for its producing better outcomes than an individual working alone. Nor are strategies for effective collaborative work taught as part of the standard curriculum at any age level (Kuhn, 2015). Arguably we must await more research on group problem solving before the sound, evidence-based curricula can be designed. Meanwhile, today's young people enter into adult work careers and social lives in which collaboration increasingly is both expected and essential, as the complexities of modern life escalate. Prior studies have shown the importance of dialogical thinking, whereby they understand insights from multiple points of view. Meta-cognitive skills may not come naturally, but it has been shown to evolve and be reciprocal (Zillmer, 2016) when considered as a development process of such discourse. Given the findings of our study, it is worthwhile to pay close attention to understand the development and formation of the metatalk in an education setting to promote productive collaboration in preparation for career success.

4.8 Study Limitations

The analysis of audio recordings of ten groups' interactions revealed the metatalk to differentiate group performance. The analyses required recording conversation streams, transcribing utterances, and coding utterances into categories. The limitations of this study are the difficulties to scale up, given the time-consuming and resource-intensive facts of human, manual coding of utterances. It could reach higher accuracy and better discourse categorization than automated text-analysis, especially in the scenario of three to four people who interact during group work. We still look forward to new computerized techniques to assess content, such as latent semantic analysis (LSA: Latent Semantic Analysis; Landauer, Foltz & Laham, 1998), to scale up the analysis of audio recordings. Other than the labor-intensive limitation, the present findings can only be generalized with caution beyond the highly educated, highly motivated sample we studied.

4.9 Future Steps

Graesser et al. (2018) suggested that automated analyses of interactions with computer-mediated communication are expected to accommodate more extensive samples of groups, broaden the diversity of populations, provide more detailed observations of group processes, and substantially speed up the process of data analyses. We anticipate it will scale up the study of metatalk and further understanding of the effects of metatalk. Further, to examine contributions at the level of the individual, the present study suggested not being sufficient, nor it's adequate to base only on groups' outcomes, either actual or self-reported. As Kapur's (2008) studies of productive failure have shown that group process and group performance do not necessarily correspond directly, our results nonetheless suggest that extension of this work to broader populations is worthwhile.

References

- Achille, L. B., Schulze, K. G., & Schimdt-Nielsen, A. (1995). An analysis of communication and use of military terms in Navy team training. *Military Psychology, 7*(2), 95-107.
- Anderson, P. H., & Lawton, L. (2009). Business simulations and cognitive learning: Developments, desires, and future directions. *Simulation & Gaming, 40*(2), 193-216.
- Apesteagua, J., Azmat, G., & Iriberry, N. (2012). The impact of gender composition on team performance and decision making: Evidence from the field. *Management Science, 58*(1), 78-93.
- Arrow, H., McGrath, J. E., & Berdahl, J. L. (2000). *Small groups as complex systems: Formation, coordination, development, and adaptation*. Sage Publications.
- Bach, M. P., Zoroja, J., & Fašnik, M. (2017). Teaching Business Simulation Games: Preliminary Current Practice Overview. In *Proceedings of the International Conference: Theory and Applications in the Knowledge Economy* (pp. 432-443).
- Balkundi, P., & Harrison, D. A. (2006). Ties, leaders, and time in teams: Strong inference about network structure's effects on team viability and performance. *Academy of Management Journal, 49*(1), 49-68.
- Barron, B. (2000). Achieving coordination in collaborative problem-solving groups. *The journal of the learning sciences, 9*(4), 403-436.
- Barron, B. (2003). When smart groups fail. *The journal of the learning sciences, 12*(3), 307-359.
- Barry, B., & Stewart, G. L. (1997). Composition, process, and performance in self-managed groups: The role of personality. *Journal of Applied psychology, 82*(1), 62.
- Beal, D. J., Cohen, R. R., Burke, M. J., & McLendon, C. L. (2003). Cohesion and performance in groups: a meta-analytic clarification of construct relations. *Journal of applied psychology, 88*(6), 989.
- Bernard, M., & Bachu, E. (2015). Enhancing the metacognitive skill of novice programmers through collaborative learning. In *Metacognition: Fundamentals, applications, and trends* (pp. 277-298).
- Brannick, M. T., Prince, A., Prince, C., & Salas, E. (1995). The measurement of the team process. *Human Factors, 37*(3), 641-651.
- Chen, G., Donahue, L. M., & Klimoski, R. J. (2004). Training undergraduates to work in organizational teams. *Academy of Management Learning & Education, 3*(1), 27-40.

- Chi, M. T. (2009). Active-constructive-interactive: A conceptual framework for differentiating learning activities. *Topics in cognitive science*, 1(1), 73-105.
- Chinn, C. A. (2006). Learning to argue. *Collaborative learning, reasoning, and technology*, 355-383.
- Chinn, C. A., Anderson, R. C., & Waggoner, M. A. (2001). Patterns of discourse in two kinds of literature discussion. *Reading Research Quarterly*, 36(4), 378-411.
- Chinn, C. A., O'donnell, A. M., & Jinks, T. S. (2000). The structure of discourse in collaborative learning. *The Journal of Experimental Education*, 69(1), 77-97.
- Chiocchio, F., & Essiembre, H. (2009). Cohesion and performance: A meta-analytic review of disparities between project teams, production teams, and service teams. *Small group research*, 40(4), 382-420.
- Cook, R. W., & Swift, C. O. (2006). The pedagogical efficacy of a sales management simulation. *Marketing Education Review*, 16(3), 37-46.
- Crowell, A., & Kuhn, D. (2014). Developing dialogic argumentation skills: A 3-year intervention study. *Journal of Cognition and Development*, 15(2), 363-381.
- Cross, R., Rebele, R., & Grant, A. (2016). Collaborative overload. *Harvard Business Review*, 94(1), 16.
- Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of educational research*, 64(1), 1-35.
- De Dreu, C. K., & Weingart, L. R. (2003). Task versus relationship conflict, team performance, and team member satisfaction: a meta-analysis. *Journal of Applied Psychology*, 88(4), 741.
- DeChurch, L. A., & Mesmer-Magnus, J. R. (2010). The cognitive underpinnings of effective teamwork: A meta-analysis. *Journal of Applied Psychology*, 95(1), 32.
- Dillenbourg, P., & Traum, D. (1999, December). The long road from a shared screen to a shared understanding. In *Proceedings CSCL*.
- Duhigg, C. (2016). What Google learned from its quest to build the perfect team. *The New York Times Magazine*, 26, 2016.
- Ellis, A. P., Bell, B. S., Ployhart, R. E., Hollenbeck, J. R., & Ilgen, D. R. (2005). An evaluation of generic teamwork skills training with action teams: Effects on cognitive and skill-based outcomes. *Personnel Psychology*, 58(3), 641-672.

- Elsass, P. M., & Graves, L. M. (1997). Demographic diversity in decision-making groups: The experiences of women and people of color. *Academy of Management Review*, 22(4), 946-973.
- Faria, A. J. (2006). History, current usage, and learning from marketing simulation games: a detailed literature review. *Proceedings of the Marketing Management Association*, 138-139.
- Feldman, D. C. (1984). The development and enforcement of group norms. *Academy of management review*, 9(1), 47-53.
- Felton, M., & Kuhn, D. (2001). The development of argumentive discourse skill. *Discourse processes*, 32(2-3), 135-153.
- Felton, M. (2004). The development of discourse strategies in adolescent argumentation. *Cognitive Development*, 19, 35-52.
- Fiore, S. M., & Salas, E. (2004). Why we need team cognition, in E. Salas & S. M. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 235-248). Washington, DC, US: American Psychological Association.
- Freedman, D., & Lane, D. (1983). A non-stochastic interpretation of reported significance levels. *Journal of Business & Economic Statistics*, 1(4), 292-298.
- Gatignon, H. (1987). Strategic studies in Markstrat. *Journal of Business Research*, 15(6), 469-480.
- Glazer, R., Steckel, J. H., & Winer, R. S. (1989). The formation of key marketing variable expectations and their impact on firm performance: Some experimental evidence. *Marketing Science*, 8(1), 18-34.
- Goldstone, R. L., Roberts, M. E., & Gureckis, T. M. (2008). Emergent processes in group behavior. *Current Directions in Psychological Science*, 17(1), 10-15.
- Grau, V., & Whitebread, D. (2012). Self and social regulation of learning during collaborative activities in the classroom: The interplay of individual and group cognition. *Learning and Instruction*, 22(6), 401-412.
- Gersick, C. J., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational behavior and human decision processes*, 47(1), 65-97.
- Graesser, A. C., Foltz, P. W., Rosen, Y., Shaffer, D. W., Forsyth, C., & Germany, M. L. (2018). Challenges of assessing collaborative problem-solving. *Assessment and teaching of 21st-century skills* (pp. 75-91).
- Gureckis, T. M., & Goldstone, R. L. (2006). Thinking in groups. *Pragmatics & Cognition*, 14(2), 293-311.

- Harrison, D. A., Price, K. H., & Bell, M. P. (1998). Beyond relational demography: Time and the effects of surface-and deep-level diversity on work group cohesion. *Academy of management journal*, 41(1), 96-107.
- Hayashi, Y. (2018). The Power of a “Maverick” in Collaborative Problem Solving: An Experimental Investigation of Individual Perspective-Taking within a Group. *Cognitive science*, 42, 69-104.
- Heerdink, M. W., Van Kleef, G. A., Homan, A. C., & Fischer, A. H. (2013). On the social influence of emotions in groups: interpersonal effects of anger and happiness on conformity versus deviance. *Journal of Personality and Social Psychology*, 105(2), 262.
- Hogan, M. J., Dwyer, C. P., Harney, O. M., Noone, C., & Conway, R. J. (2015). Metacognitive skill development and applied systems science: A framework of metacognitive skills, self-regulatory functions, and real-world applications. In *Metacognition: Fundamentals, applications, and trends* (pp. 75-106).
- Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences*, 101(46), 16385-16389.
- Hoogendoorn, S., Oosterbeek, H., & Van Praag, M. (2013). The impact of gender diversity on the performance of business teams: Evidence from a field experiment. *Management Science*, 59(7), 1514-1528.
- Horwitz, S. K., & Horwitz, I. B. (2007). The effects of team diversity on team outcomes: A meta-analytic review of team demography. *Journal of Management*, 33(6), 987-1015.
- Hu, J., & Liden, R. C. (2015). Making a difference in the teamwork: Linking team prosocial motivation to team processes and effectiveness. *Academy of Management Journal*, 58(4), 1102-1127.
- Johnson, D. W., & Johnson, R. T. (2004). The three Cs of promoting social and emotional learning. *Building academic success on social and emotional learning: What does the research say*, 40-58.
- Johnson, R. T., & Johnson, D. W. (2008). Active learning: Cooperation in the classroom. *The annual report of educational psychology in Japan*, 47, 29-30.
- Kapur, M. (2008). Productive failure. *Cognition and instruction*, 26(3), 379-424.
- Karau, S. J., & Kelly, J. R. (1992). The effects of time scarcity and time abundance on group performance quality and interaction process. *Journal of experimental social psychology*, 28(6), 542-571.

- Kelly, J. R., & Karau, S. J. (1999). Group decision making: The effects of initial preferences and time pressure. *Personality and Social Psychology Bulletin*, 25(11), 1342-1354.
- Kilduff, M., Angelmar, R., & Mehra, A. (2000). Top management team diversity and firm performance: Examining the role of cognition. *Organization Science*, 11(1), 21-34.
- King, A. (1999). Discourse patterns for mediating peer learning.
- Klimoski, R., & Mohammed, S. (1994). Team mental model: Construct or metaphor? *Journal of Management*, 20(2), 403-437.
- Kuhn, D. (2000). Metacognitive development. *Current directions in psychological science*, 9(5), 178-181.
- Kuhn, D. (2015). Thinking together and alone. *Educational Researcher*, 44(1), 46-53.
- Kuhn, D., Goh, W., Iordanou, K., & Shaenfield, D. (2008). Arguing on the computer: A microgenetic study of developing argument skills in a computer-supported environment. *Child Development*, 79(5), 1310-1328.
- Kuhn, D., Zillmer, N., Crowell, A., & Zavala, J. (2013). Developing norms of argumentation: Metacognitive, epistemological, and social dimensions of developing argumentative competence. *Cognition and Instruction*, 31(4), 456-496.
- Lai, E., DiCerbo, K., & Foltz, P. (2017). *Skills for Today: What We Know about Teaching and Assessing Collaboration*. Pearson.
- Lai, H. Y., Floyd, D., Hibbard, K., Corter, J., & Cartolano, L. (2016). Effects of Assigned Task Roles on Process and Performance in a Collaborative Optimization Task, *Proceeding of Collective Intelligence Conference*, New York, June 2016
- Lambert, D. R. (1980, March). On compensatory demand functions in marketing simulations. In *Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL conference (Vol. 7)*.
- Larreche, J. C., & Gatignon, H. (1977). *MARKSTRAT: A marketing strategy game (Vol. 1)*. Course Technology.
- Martin, L. L., & Clark, L. F. (1990). Social cognition: Exploring the mental processes involved in human social interaction. In *Aspects of this chapter were discussed at the annual meeting of the Person Memory Interest Group in Tempe, Arizona, Oct 1986, and at the Nag's Head Conference on Social Cognition in Kill Devil Hills, North Carolina, Jun 1987*. John Wiley & Sons.
- Mesmer-Magnus, J. R., & DeChurch, L. A. (2009). Information sharing and team performance: A meta-analysis. *Journal of Applied Psychology*, 94(2), 535.

- Miyake, N. (1986). Constructive interaction and the iterative process of understanding. *Cognitive science*, 10(2), 151-177.
- Mohammed, S., Ferzandi, L., & Hamilton, K. (2010). Metaphor no more: A 15-year review of the team mental model construct. *Journal of Management*, 36(4), 876-910.
- Page, S. E. (2010). *Diversity and complexity* (Vol. 2). Princeton University Press.
- Papathomas, L., & Kuhn, D. (2017). Learning to argue via apprenticeship. *Journal of Experimental Child Psychology*, 159, 129-139.
- Parks, C. D., & Cowlin, R. (1995). Group discussion as affected by the number of alternatives and by a time limit. *Organizational Behavior and Human Decision Processes*, 62(3), 267-275.
- Pasin, F., & Giroux, H. (2011). The impact of a simulation game on operations management education. *Computers & Education*, 57(1), 1240-1254.
- Phelps, E., & Damon, W. (1989). Problem solving with equals: Peer collaboration as a context for learning mathematics and spatial concepts. *Journal of Educational Psychology*, 81(4), 639.
- Pifarre, M., & Cobos, R. (2010). Promoting metacognitive skills through peer scaffolding in CSCL environment. *International Journal of Computer-Supported Collaborative Learning*, 5(2), 237-253.
- Raes, A., Schellens, T., De Wever, B., & Benoit, D. F. (2016). Promoting metacognitive regulation through collaborative problem solving on the web: When scripting does not work. *Computers in Human Behavior*, 58, 325-342.
- Rapanta, C., Garcia-Mila, M., & Gilabert, S. (2013). What is meant by argumentative competence? An integrative review of methods of analysis and assessment in education. *Review of Educational Research*, 83(4), 483-520.
- Rogoff, B. (1998). Cognition as a collaborative process.
- Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *The journal of the learning sciences*, 2(3), 235-276.
- Rozovsky, J. (2015, November 17). The five keys to a successful Google team. Retrieved from <https://rework.withgoogle.com/blog/five-keys-to-a-successful-google-team/>
- Salas, E., Dickinson, T. L., Converse, S. A., & Tannenbaum, S. I. (1992). Toward an understanding of team performance and training.

- Salas, E., Shuffler, M. L., Thayer, A. L., Bedwell, W. L., & Lazzara, E. H. (2015). Understanding and improving teamwork in organizations: A scientifically based practical guide. *Human Resource Management, 54*(4), 599-622.
- Schwartz, D. L. (1995). The emergence of abstract representations in dyad problem solving. *The journal of the learning sciences, 4*(3), 321-354.
- Shaenfield, D. (2009). *The role of meta-level regulation in developing argumentive discourse skills*. Columbia University.
- Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary educational psychology, 21*(1), 43-69.
- Stevens, M. J., & Campion, M. A. (1994). The knowledge, skill, and ability requirements for teamwork: Implications for human resource management. *Journal of Management, 20*(2), 503-530.
- Stewart, G. L. (2006). A meta-analytic review of relationships between team design features and team performance. *Journal of Management, 32*(1), 29-55.
- Tyler, T. R., & Blader, S. L. (2003). The group engagement model: Procedural justice, social identity, and cooperative behavior. *Personality and social psychology review, 7*(4), 349-361.
- Terry, D. J., & Hogg, M. A. (1996). Group norms and the attitude-behavior relationship: A role for group identification. *Personality and social psychology bulletin, 22*(8), 776-793.
- Terry, D. J., Hogg, M. A., & White, K. M. (1999). The theory of planned behavior: self-identity, social identity and group norms. *British journal of social psychology, 38*(3), 225-244.
- Udell, W. (2007). Enhancing adolescent girls' argument skills in reasoning about personal and non-personal decisions. *Cognitive Development, 22*, 341-352.
- Webb, N. M. (1991). Task-related verbal interaction and mathematics learning in small groups. *Journal for research in mathematics education, 22*(5), 366-389.
- Webb, N. M., & Mastergeorge, A. (2003). Promoting effective helping behavior in peer-directed groups. *International Journal of Educational Research, 39*(1-2), 73-97.
- Webb, N. M., Troper, J. D., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. *Journal of educational psychology, 87*(3), 406.
- Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative science quarterly, 38*, 357-381.

- Wildman, J. L., Thayer, A. L., Pavlas, D., Salas, E., Stewart, J. E., & Howse, W. R. (2012). Team knowledge research: Emerging trends and critical needs. *Human Factors*, 54(1), 84-111.
- Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. (2010). Evidence for a collective intelligence factor in the performance of human groups. *Science*, 330(6004), 686-688.
- Zavala, J., & Kuhn, D. (2017). Solitary discourse is a productive activity. *Psychological science*, 28(5), 578-586.
- Zillmer, N. S. (2016). Metacognitive dimensions of adolescents' intellectual collaboration (Doctoral dissertation, Teachers College).
- Zillmer, N., & Kuhn, D. (2018). Do similar-ability peers regulate one another in a collaborative discourse activity? *Cognitive Development*, 45, 68-76
- Zucker, L. G. (1977). The role of institutionalization in cultural persistence. *American sociological review*, 726-743.

Appendix A

Questionnaire

(Distributed at the End of the Second and the Seventh Decision Period)

When you have concluded your decision making, before leaving your study room.

Please turn off the recorder and briefly answer these questions.

1. I am (circle one) Member A Member B Member C Member D

2. List in a few words, the main factors that contributed to the decisions your

Markstrat firm made for this decision:

3. What percentage influence do you believe you had on these decisions?

___% (enter a figure from 0% to 100%)

4. What percentage influence do you believe each of the other members had?

___% ___% ___%

5. If you had been making your firm's decisions alone, do you believe the decisions

would have been

___better ___same ___worse (check one)

6. Did your group work well together in this decision-making session?

very well...../...../...../...../...../...../...../...../.....very poorly

Appendix B

Decision period 2 questionnaire response results

	# of participants	Q3. self-influence	Q5. self-decision	Q6. group work
Group 1 (highest)	4	20	1.25	8.25
Group 2	4	25	1.50	8.50
Group 3	3	45	1.67	7.33
Group 4	4	25	1.00	9.00
Group 5	3	42	1.33	9.00
Group 6	3	43.3	2.33	4.33
Group 7	3	32	1.67	8.67
Group 8	4	27	1.75	8.25
Group 9	3	33	1.33	9.00
Group 10 (lowest)	4	23.75	1.25	8.00

Note. Very well = 9, very poorly = 1;

better = 3, same = 2, worse = 1;

Appendix C

Decision period 7 questionnaire response results

	# of participants	Q3. self-influence	Q5. self-decision	Q6. group work
Group 1 (highest)	4	21.25	1.50	7.50
Group 2	4	28.75	1.25	9.00
Group 3	3	36.00	1.33	7.00
Group 4	4	23.75	1.00	9.00
Group 5	3	30.33	1.33	9.00
Group 6	3	38.67	2.00	6.67
Group 7	3	32.00	1.67	8.33
Group 8	4	27.00	1.50	7.50
Group 9	3	33.00	1.00	9.00
Group 10 (lowest)	4	25.00	1.50	7.50

Appendix D

Final Reflection Questionnaire

(Distributed at the End of the Eighth Decision Period)

1. What percentage influence do you believe you had overall on your firm's decisions?

___% (enter a figure from 0% to 100%)

2. What percentage influence do you believe each of the other members had?

___% ___% ___% (enter a figure for each of the other members)

3. Did your firm make good decisions well overall?

very well...../...../...../...../...../...../...../...../.....very poorly

4. Did group effectiveness change over time?

___got better ___stayed same ___got worse (check one)

5. Did your firm work well together overall?

very well...../...../...../...../...../...../...../...../.....very poorly

6. Did you know most of the other group members well prior to this experience?

very well...../...../...../...../...../...../...../...../.....not at all

7. If you had been deciding alone, do you believe your decisions would have been

___better ___same ___worse (check one)

8. How competent do you consider yourself in market strategy decision making?

very competent ----/----/----/----/----/----/----/----/---- very poor

Appendix E

Decision period 8 questionnaire response results

	Q1. self-influence (%)	Q7. self-decision	Q5. group work
Group 1 (highest)	27.50	1.00	8.50
Group 2	26.25	1.25	9.00
Group 3	40.00	1.33	7.67
Group 4	25.00	1.00	8.25
Group 5	33.00	1.00	9.00
Group 6	32.10	2.33	6.00
Group 7	NA	NA	NA
Group 8	39.50	1.75	7.50
Group 9	31.67	1.67	9.00
Group 10 (lowest)	NA	NA	NA

Note. Very well = 9, very poorly = 1;
 better = 3, same = 2, worse = 1;
 Very competent = 9, very poor = 1

Cont. Decision period 8 questionnaire response results

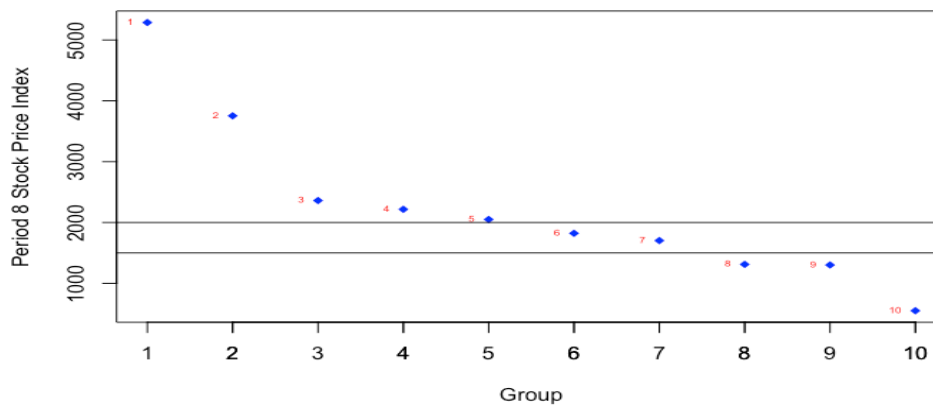
	Q3. group-decision	Q4. group-effectiveness	Q6. each other	Q8. self-competence
Group 1 (highest)	8.25	2.50	1.00	6.25
Group 2	8.75	2.50	1.75	6.75
Group 3	6.33	2.67	2.33	7.33
Group 4	8.25	3.00	1.00	7.00
Group 5	9.00	3.00	1.00	6.00
Group 6	6.33	3.00	2.00	5.33
Group 7	NA	NA	NA	NA
Group 8	5.50	1.75	1.00	6.00
Group 9	7.67	3.00	3.33	3.00
Group 10 (lowest)	NA	NA	NA	NA

Note. One participant from group 7 did not submit the final questionnaire and a similar case for group 10.

Appendix F

Key performance indicators across the ten groups

PERIOD 8 PERFORMANCE	SPI (index)	REVENUE (dollars)	<i>MARKET SHARE</i> (percentage)	<i>CUMULATIVE NET CONTRIBUTION</i> (dollars)
Group 1	5287	413	48.6	845
Group 2	3753	304	35.8	594
Group 3	2361	185	22	404
Group 4	2217	165	19.6	355
Group 5	2050	122	14.3	255
Group 6	1822	140	16.6	206
Group 7	1703	129	15.1	188
Group 8	1312	94	11.3	220
Group 9	1302	98	11.7	219
Group 10	550	44	5.1	61



Appendix G

Groups' discussion times for full sample

DECISION PERIOD	<i>Minimum</i> (Minutes)	Median (Minutes)	<i>Maximum</i> (Minutes)	<i>Average</i> (Minutes)
1	69	105	120	102.3
2	64	113.5	163	116.1
3	12	87	155	91.4
4	62	105.5	132	103.0
5	30	94.5	165	94
6	71	111.5	198	125.9
7	14	58	113	62
8	17	40	93	51.3

Appendix H

The average number of idea units in 10-minute segments of discourse for each group ranked by performance

10-minute Discourse	PERIOD 2 (Units)	PERIOD 7 (Units)
Group 1 (highest)	102	155
Group 2	149	124
Group 3	137	175
Group 4	111	95
Group 5	140	149
Group 6	173	170
Group 7	204	198
Group 8	99	125
Group 9	151	123
Group 10 (lowest)	152	96

Appendix I

Frequency and percentage usage of selected discourse types in 10-minute segments of discourse during Period 2

	Meta-Self	Meta-Group	Agree Question	<i>Agree</i>	<i>Counter</i>
Group 1 (highest)	2 (2.0%)	20 (11.8%)	0 (0%)	20 (19.6%)	3 (2.9%)
Group 2	14 (9.4%)	20 (13.4%)	1 (0.7%)	20 (13.4%)	4 (2.7%)
Group 3	12 (8.8%)	20 (14.6%)	2 (1.5%)	17 (12.4%)	5 (3.6%)
Group 4	10 (9.0%)	9 (8.1%)	5 (4.5%)	16 (14.4%)	5 (4.5%)
Group 5	12 (8.6%)	12 (8.6%)	4 (2.9%)	20 (14.3%)	13 (9.3%)
Group 6	14 (8.1%)	19 (11.0%)	4 (2.3%)	23 (13.3%)	7 (4.0%)
Group 7	9 (4.4%)	32 (15.7%)	4 (2.0%)	20 (9.8%)	24 (11.8%)
Group 8	3 (3.0%)	4 (4.0%)	1 (1.0%)	16 (16.2%)	1 (1.0%)
Group 9	9 (6.0%)	17 (11.3%)	6 (4.0%)	22 (14.6%)	0 (0%)
Group 10 (lowest)	28 (18.4%)	4 (2.6%)	3 (2.0%)	19 (12.5%)	7 (4.6%)

Appendix J

Frequency and percentage usage of selected discourse types in 10-minute segments of discourse during Period 7

	Meta-Self	Meta-Group	Agree Question	<i>Agree</i>	<i>Counter</i>
Group 1 (highest)	6 (3.9%)	43 (27.7%)	0 (0%)	17 (11.0%)	5 (3.2%)
Group 2	10 (8.1%)	23 (18.5%)	1 (0.8%)	16 (12.9%)	1 (0.8%)
Group 3	17 (9.7%)	22 (12.6%)	2 (1.1%)	20 (11.4%)	22 (12.6%)
Group 4	7 (7.4%)	12 (12.6%)	2 (2.1%)	12 (12.6%)	3 (3.2%)
Group 5	16 (10.7%)	21 (14.1%)	2 (1.3%)	9 (6.0%)	8 (5.4%)
Group 6	18 (10.6%)	27 (15.9%)	6 (3.5%)	22 (12.9%)	9 (5.3%)
Group 7	18 (9.1%)	28 (14.1%)	8 (4.0%)	20 (10.1%)	29 (14.6%)
Group 8	16 (12.8%)	14 (11.2%)	0 (0%)	7 (5.6%)	10 (8.0%)
Group 9	9 (7.3%)	29 (23.6%)	2 (1.6%)	15 (12.2%)	2 (1.6%)
Group 10 (lowest)	17 (17.7%)	9 (9.4%)	4 (4.2%)	6 (6.3%)	4 (4.2%)

Appendix K

*Correlation between the **frequency** of utterance usage and SPI for period 2 of the full sample (n = 10)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.29	–			
3. Counter	0.16	0.24	–		
4. Meta-Self	0.15	0.24	0.14	–	
5. Meta-Group	0.46	0.03	0.54	-0.27	–
6. SPI	0.07	-0.61	-0.18	-0.48	0.38

*Correlations between the **frequency** of utterance usage and SPI for period 2 of the middle performing groups (n = 8)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.41	–			
3. Counter	0.18	0.17	–		
4. Meta-Self	0.51	0.11	0.14	–	
5. Meta-Group	0.50	0.13	0.66	0.44	–
6. SPI	-0.05	-0.47	-0.05	0.65	0.19

Note. Correlation analysis of the eight middle-performing groups (excluding the highest and lowest performing groups)

Appendix L

*Correlations between the **frequency** of utterance usage and SPI for period 7 of the full sample (n = 10)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.42	–			
3. Counter	0.45	0.57	–		
4. Meta-Self	0.02	0.59	0.62	–	
5. Meta-Group	0.65	-0.01	0.12	-0.34	–
6. SPI	0.38	-0.44	-0.17	-0.62	0.69*

Note. r (Meta-Self, SPI) = -0.62, p -value = 0.0575; r (Meta-Group, SPI) = 0.69, p -value = 0.0275

*Correlations between the **frequency** of utterance usage and SPI for period 7 of the middle performing groups (n = 8)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.70	–			
3. Counter	0.45	0.61	–		
4. Meta-Self	0.31	0.49	0.74	–	
5. Meta-Group	0.69	0.60	0.26	0.29	–
6. SPI	0.18	-0.22	-0.24	-0.29	-0.07

Note. Correlation analysis of the eight middle-performing groups (excluding the highest and lowest performing groups)

Appendix M

*Correlations between the **proportion** of utterance usage and SPI for period 2 of the full sample (n = 10)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	-0.29	–			
3. Counter	-0.55	0.09	–		
4. Meta-Self	-0.45	0.24	0.07	–	
5. Meta-Group	0.14	-0.36	0.14	-0.56	–
6. SPI	0.59	-0.54	-0.11	-0.45	0.76*

Note. A significant correlation between SPI and Meta-Group (p -value = 0.0111)

*Correlations between the **proportion** of utterance usage and SPI for period 2 of the middle performing groups (n = 8)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.17	–			
3. Counter	-0.69	0.02	–		
4. Meta-Self	-0.05	0.18	0.01	–	
5. Meta-Group	-0.88	-0.19	0.36	0.28	–
6. SPI	-0.17	-0.38	0.01	0.71*	0.38

Note. A significant correlation between SPI and Meta-Self (p -value = 0.0484)

Appendix N

*Correlations between the **proportion** of utterance usage and SPI for period 7 of the full sample ($n = 10$)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.02	–			
3. Counter	-0.21	0.25	–		
4. Meta-Self	-0.67	0.48	0.18	–	
5. Meta-Group	0.48	-0.42	-0.44	-0.79	–
6. SPI	0.42	-0.58	-0.26	-0.76*	0.70*

Note. Significant correlations between SPI and Meta-Self (p -value = 0.0105); SPI and Meta-Group (p -value = 0.025)

*Correlations between the **proportion** of utterance usage and SPI for period 7 of the other groups ($n = 8$)*

Measure	1	2	3	4	5
1. Agree	–				
2. Agree Q	0.40	–			
3. Counter	-0.30	0.32	–		
4. Meta-Self	-0.76	-0.25	0.39	–	
5. Meta-Group	0.48	0.07	-0.58	-0.59	–
6. SPI	0.40	-0.21	-0.30	-0.35	0.06