

WIKI-INDUCED COGNITIVE ELABORATION IN PROJECT TEAMS: AN EMPIRICAL STUDY

Completed Research Paper

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Abstract

Researchers have exerted increasing efforts to understand how wikis can be used to improve team performance. Previous studies have mainly focused on the effect of the quantity of wiki use on performance in wiki-based communities; however, only inconclusive results have been obtained. Our study focuses on the quality of wiki use in a team context. We develop a construct of wiki-induced cognitive elaboration, and explore its nomological network in the team context. Integrating the literatures on wiki and distributed cognition, we propose that wiki-induced cognitive elaboration influences team performance through knowledge integration among team members. We also identify its team-based antecedents, including task involvement, critical norm, task reflexivity, time pressure and process accountability, by drawing on the motivated information processing literature. The research model is empirically tested using multiple-source survey data collected from 46 wiki-based student project teams. The theoretical and practical implications of our findings are also discussed.

Keywords: knowledge integration, wiki-induced cognitive elaboration, task involvement, critical norm, time pressure, process accountability, task reflexivity.

Introduction

Contemporary teams use collaborative technologies to enhance teamwork and achieve superior team performance (Bélanger and Allport 2008; Carte and Chidambaram 2004; Easley et al. 2003). Wiki, an emerging web 2.0 collaborative technology, enabling members to engage in collective editing and knowledge co-creation (Menchen-Trevino et al. 2009), is deployed as a popular information technology (IT) tool in supporting teamwork (Dishaw et al. 2008; Menchen-Trevino et al. 2009). For instance, many enterprises, such as Adobe, IBM and Sun Microsystems, have been increasingly using wikis to facilitate teamwork (Confluence). However, the deployment of wikis in teams does not guarantee that such teams can achieve satisfactory performance. It is important to exert more research efforts to understand the extent to and the process by which wikis can be used to improve team performance.

Our existing knowledge on wiki use has mainly been contextualized in wiki-based communities (e.g., Wikipedia). To understand the performance implications of wiki use, most of the earlier studies have focused on the impact of the quantity of wiki use on performance, with inconclusive results. On the one hand, some research findings imply that frequent use of wiki leads to better performance. For instance, according to Wilkinson and Huberman (2007), high-quality articles in Wikipedia can be attributed to a larger number of edits. Likewise, for Kittur and Kraut (2008), the number of editors improves article quality in Wikipedia. However, the same study observed a negative relationship between the number of editors and quality improvements in wiki articles under the condition of low editor concentration (i.e., the editors make relatively equal edits).

Previous works' focus on quantity and their inconclusive results lead us to ask the question "Is the quantity of wiki use really as important as originally assumed?" We turn this unsettled question to a call for a deeper understanding of what really underlies the wiki-usage behavior, which ultimately contributes to the effective completion of teamwork using wiki. In our opinion, studying the quality of wiki use provides a stronger explanation to team performance. In short, if the participation quality is high, the need for revisions is reduced, and better performance can be achieved with less edit quantity. To the best of our knowledge, however, previous studies have neglected this important issue.

The main objective of our study is to meet this research gap by investigating the quality aspect of wiki use. Specifically, we address such quality aspect by developing a construct called wiki-induced cognitive elaboration and examining its antecedents and team performance consequences. Cognitive elaboration reflects the efforts that people spend mentally, as opposed to behaviorally, in processing relevant information (Chow and Luk 2006; Petty and Cachon 1986). We propose that the level of cognitive elaboration expended in using wikis, rather than the actual wiki use frequency, would influence performance in wiki-based teams. Specifically, we identify knowledge integration as the mechanism through which wiki-induced cognitive elaboration influence team performance. Furthermore, we explore its team-based antecedents by drawing on the motivated information processing literature from social psychology. In developing this construct and exploring its nomological network in the team context, our study contributes to the literature by uncovering an important aspect of wiki use for the team setting.

In the following sections, we review the relevant literature on wikis, after which we provide the theoretical background of the study. Then, we present the research model and develop the hypotheses. Thereafter, we describe the research methodology, analyze the data, and report the hypotheses testing results. Finally, we discuss our research findings and its contribution to research and practice.

Theoretical Background

Wiki Research

Wiki is "a set of linked Web pages created incrementally by a group of collaborating users" (Wagner and Bolloju 2005, p. 4). It allows collective editing (Kane and Fichman 2009), i.e., many people can co-edit the same Web pages in a wiki website (e.g., add new wiki pages or edit existing wiki pages). Wiki is a new collaborative technology that has been increasingly used to achieve various business goals (Moskaliuk et al. 2009; Wagner and Majchrzak 2006).

Unlike other widely used collaborative technologies, wiki is distinct in its ability to support “open editing” (Kane and Fichman 2009), a function through which everyone can edit wiki pages. Specifically, every edit of a page may improve the content of a wiki page to some extent; even if the edits are not accurate, other users can correct them. In the long run, the content of wiki pages can be improved gradually by the crowds, an effect seen as the “wisdom of crowds” (Surowiecki 2005). Wikipedia is an excellent example of a wiki website with high-quality content created by the crowds.

Another distinct characteristic of wiki is “edit preservation” (Kane and Fichman 2009), i.e., every edit to a wiki page is recorded in a history page; visiting previous edits or rolling back to any previous versions is easy (Kane and Fichman 2009). Every wiki page has a history page that contains the history of edits related to the page, including *who* made *what* editing at *when*. Thus, it does not require effort from any user in identifying who edited which pages, the content of the edits, and the time of the edits.

As an instance of collaborative technology, wiki has been widely used in supporting team collaboration (Moskaliuk et al. 2009), thereby giving rise to the need to develop a better understanding of wiki use and its performance outcomes in team context. A careful review of wiki literature shows that previous research has mainly studied the relationship between the quantity of edits and the quality of the articles in Wikipedia (Wilkinson and Huberman 2007). Research has found that the quantity of edits can positively influence article quality; however, “edit wars” may occur if editors have many conflicts and do not communicate well (Wilkinson and Huberman 2007). Edit wars result in a large quantity of wiki edits, but these are likely to damage team performance.

However, the current study focuses on wiki-based teams, i.e., teams that use wiki technology as a primary IT platform for collaboration. Wiki-based teams differ from wiki communities in important ways. First, only a limited number of people in a team can view and edit the wiki content. Second, teams using wiki to accomplish team tasks have a relatively clear goal and timeline: they may need to finish their content building before a deadline. In this case, they may not have as much time to allow a large number of iterations on the content. Unlike Wikipedia, where errors can be corrected through ever-lasting iterations, the errors of group wiki, if any, should be corrected before the deadline. Such limitation requires team members to be more careful and exert more cognitive effort when editing the wiki. Eventually, if team members make many edits without thoughtful consideration, these mindless edits may damage their team performance.

Thus, we postulate that the quality of wiki use should play an even more important role in influencing team performance using wiki for collaboration. For example, team members may have different or unique opinions toward the same issues, and add different contents in the same wiki page. If they ignore the others’ writings, the resulting content in the wiki will be chaotic and incoherent, and will reflect pieces of different people’s writing. Otherwise, if they just insist their own opinion and delete that of others without evaluating it, this disregard of the point of view of other people can hinder effective content building. To guarantee effective collective content building, people should spend cognitive effort in understanding the current content of the wiki when they try to improve its content. On the basis of their understanding of current wiki content, people can determine how to add their own understanding in improving the wiki. In this case, the quality of wiki participation is said to be high. In the following section, we conceptualize this cognitive aspect of wiki collaboration by developing the notion of *wiki-induced cognitive elaboration*.

Defining Wiki-induced Cognitive Elaboration

Cognitive elaboration refers to the extent to which people think about and cognitively process issue-relevant information (Chow and Luk 2006; Petty and Cacher 1986). It is a construct that reflects the varying degree of cognitive effort that people exert when processing received information. People have a high level of cognitive elaboration if they thoughtfully process and scrutinize different pieces of relevant information to understand and assimilate them, and try to draw conclusion based on the systematic processing and relational consideration of all relevant information (De Dreu 2007). On the contrary, if people superficially process relevant information, such as ignore relevant information or just accept it without processing it cognitively, they have a low level of cognitive elaboration.

We use the concept of *wiki-induced cognitive elaboration* to capture the inherent cognitive effort that team members spend in elaborating and processing an issue-relevant information using wiki. By “wiki-induced,” we mean that some characteristics of wiki can induce people’s cognitive elaboration of relevant

information when they are working with wiki. We make this argument based on the literature on distributed cognition (Boland Jr et al. 1994). Team members that are working together using wiki may be viewed as a form of distributed cognitive activity, in which individual members autonomously make and exchange interpretations with other team members to achieve the team goal based on the comprehensive understanding of their own and others' interpretations (Boland Jr et al. 1994). In this process, they need to make interpretations (e.g., express their own understanding and opinion), exchange ideas with others, and understand others' interpretations. Through this cyclic process, individually held information can be gradually integrated together, which will ultimately lead to a joint solution that combines the effort and understanding of multiple team members.

Such distributed cognitive activity is suggested to be enabled by the following IT design principles: ownership (every interpretation is owned by an individual), easy travel (there are easy to follow links within and between interpretations), and multiplicity (multiple interpretations can be made toward the same issue) (Boland Jr et al. 1994)¹. IT systems that support these principles are believed to help people's interpretation of relevant information and others' elaboration and absorption of this information (Majchrzak et al. 2005).

We suggest that wiki is such a technology that supports these features. First, although wiki does not highlight individual authorship, its edit preservation function makes it easy to find the *authorship* of every edit. This attribute makes it possible for one person to start a dialogue with the edit's author to discuss the changes (e.g., the rationale behind the edit), which can help in understanding the edit.

Second, the easy travel function is supported by the wiki system. Through the open editing function of wiki, members can add citations to support and supplement their edits in the wiki, and other people can follow these links to get a better understanding of the issue. The structure in wiki is easy to follow, and it is convenient for users to view different wiki pages for them to evaluate and understand.

Third, wiki supports multiplicity through its open editing function: all the team members can share relevant information in the same wiki pages. The wiki system also helps people to compare different interpretations. For example, in the history pages, members can view the different edits and understand the process by which sets of individually held information are gradually integrated together. They can also compare the different versions of the same page. Through this comparison, they can clearly see the evaluation processes of each page. This feature is very useful in evaluating and processing relevant information.

Thus, we believe that the notion of wiki-induced cognitive elaboration capture the extent to which team members engage in cognitive elaboration using the wiki platform. Team members with high wiki-induced cognitive elaboration will spend much effort to understand the current content presented in the wiki platform, evaluate them, find their merits and shortcomings, and then consider ways to resolve the shortcomings and improve the content. On the contrary, members with low wiki-induced cognitive elaboration may just make their own wiki edits without critically considering how their edits relate to the current wiki content.

Wiki may be suitable to induce cognitive elaboration to some extent; however, people do not automatically engage in cognitive elaboration when they are working on a project using wiki. In addition, the importance of this construct will not be clear unless we examine its impact on team performance. Thus, learning what factors can influence wiki-induced cognitive elaboration, as well as whether and how wiki-induced cognitive elaboration affects team performance, is crucial. In the next section, we develop the theory to understand the performance outcomes of wiki-induced cognitive elaboration and draw on the motivated information processing theory to examine its situational antecedents.

¹ The other three IT design principles are indeterminacy, emergence, and mixed forms. These principles are not included in this paper because we believe they are not relevant; thus, we do not use them in later discussions.

The Motivated Information Processing Theory

Originated from dual process models (Reinhard and Sporer 2008), the motivated information-processing literature (De Dreu 2003; De Dreu 2007; De Dreu et al. 2006; De Dreu et al. 2003) provides a useful lens through which we can study the antecedents of wiki-induced cognitive elaboration in teams. The motivated information processing literature is originally developed to study information exchange and processing in negotiations (De Dreu et al. 2003). The basic idea is that the more careful in exchanging and processing of relevant information, the stronger cognitive elaboration is, and the more likely people will overcome human cognitive limitation and achieve integrative negotiation (De Dreu et al. 2003) because of the “*analytic and comprehensive treatment of judgment-relevant information*” (Reinhard and Sporer 2008, p. 74).

Some researchers have studied the factors that influence people’s information processing during interpersonal negotiation based on dual process models (Chaiken and Trope 1999). The extent to which individuals are motivated to engage in cognitive elaboration of issue-relevant information can be triggered by situational cues (De Dreu 2007; De Dreu et al. 2003). Situational cues refer to contextual cues that people face. Through experiments, researchers have found that time pressure (De Dreu 2003) and process accountability (De Dreu et al. 2000) are two important factors that can influence cognitive elaboration in an interpersonal negotiation context. Process accountability refers to the expectation that one may be called on to explain and justify his/her working processes (Lerner and Tetlock 1999). These two factors are included to examine whether they can affect team context.

Task involvement is another important factor that may influence cognitive elaboration. It reflects the extent to which team members are involved with the group task and view the task as important and interesting (Kim et al. 2009; Zaichkowsky 1994). It can be viewed as the attitude of team members toward their task. Its effect on cognitive elaboration is discussed but not tested in the motivated information processing literature.

Group norm can play an important role in groups (Postmes et al. 2001, p. 919). Critical norm is a group norm that values and supports deviance and critical thoughts (Postmes et al. 2001). In this paper, critical norm was included to capture the norm aspect of team. Its role in influencing cognitive elaboration has been argued without empirical research in the motivated information processing literature.

Task reflexivity is another important antecedent factor. It is defined as “the extent to which team members overtly reflect upon the group’s objectives, strategies, and processes, and adapt them to current or anticipated endogenous or environmental circumstances” (West 1996, p. 559). In studying teams, De Dreu (2007) have used it as the sole antecedent to cognitive elaboration to study its effect. However, they did not test it empirically. In the present study, this important factor is included to enrich the model and provide empirical support.

Research Model and Hypothesis

Figure 1 shows the research model. First, wiki-induced cognitive elaboration is hypothesized to influence team performance through the mediation of team knowledge integration. Second, process accountability, task involvement, time pressure, task reflexivity, and critical norm are hypothesized to influence wiki-induced cognitive elaboration.

Consequence of Wiki-induced Cognitive Elaboration

In this paper, we identify the way by which wiki-induced cognitive elaboration can influence wiki content quality, a major indicator of team performance in wiki-based project teams. Specifically, we argue that

wiki-induced cognitive elaboration can influence knowledge integration², which ultimately influences wiki content quality. These relationships are explained in the following section.

Wiki-induced Cognitive Elaboration and Knowledge Integration

Knowledge integration is “the synthesis of individuals' specialized knowledge into situation-specific systemic knowledge” (Alavi and Tiwana 2002, p. 1030). In the context of collective wiki content building, it refers to the synthesis of individually held information of team member that is relevant to their group task.

Boland Jr and Tenkasi (1995) have proposed that knowledge integration in organizations requires the ability to make strong perspectives (perspective making), and the ability to take the perspectives of others (perspective taking) into account. There are different communities of knowing in an organization. These communities of knowing can develop and reinforce their own knowledge domains through the process of perspective making. Perspective making is the process of developing knowledge and strengthening the own knowledge domain of communities (Boland Jr and Tenkasi 1995). The goal is to summarize and reinforce what the communities already know. Communities can reflect on their own knowledge, analyze it rationally, and make further revisions. Through these processes, the knowledge domains of the communities of knowing are strengthened. The successful operation of an organization needs the knowledge of different communities of knowing. Thus, communities need to appreciate and utilize others' knowledge through the process of perspective taking (Boland Jr and Tenkasi 1995). For example, they need to know what others know, analyze the knowledge of others, and combine external knowledge with what they know to enrich and strengthen their own knowledge domains. In summary, through the process of perspective making, the internal knowledge of a community is integrated, and through the process of perspective taking, the knowledge of different communities of knowing are accessed by others, leading to knowledge integration in the whole organization. All these efforts pertaining to knowledge integration require the individuals to engage in deep cognitive elaboration on relevant information. Indeed, prior research has implied the importance of cognitive elaboration in influencing knowledge integration by referring to the “thoughtful consideration” of knowledge (Robert et al. 2008 , p.315).

The role of cognitive elaboration in affecting knowledge integration can be appropriated in the team context. As an example of a collective of individuals, a team can be viewed as a collective of distributed cognitive processing units, in which individual members autonomously make and exchange interpretations with other team members in order to achieve the team goal based on the comprehensive understanding of their own and others' interpretations (i.e., a form of knowledge integration) (Boland Jr et al. 1994). In this process, team members must make their own perspectives (e.g., express their own understanding and opinion), exchange ideas with others, and understand others' perspectives. Through this cyclic process, individually held information can be integrated gradually, ultimately leading to a joint solution combining the effort and understanding of multiple team members (Boland Jr et al. 1994).

Cognitively elaborating on relevant knowledge during perspective taking and perspective making is important for the team. Individually held knowledge may be problematic and even incorrect (Carlile and Rebentisch 2003; Davenport and Prusak 1998). There may also be some conflicts among the sets of knowledge held by individuals (Carlile and Rebentisch 2003). When team members engage in a high-level cognitive elaboration (e.g., carefully processing and analyzing wiki content), they are more likely to understand them, find similarities and differences, find possible errors, resolve possible conflicts, and integrate them with prior knowledge. Along with the theory of knowledge integration by Boland Jr and Tensaki (Boland Jr and Tenkasi 1995), wiki-induced cognitive elaboration during perspective making and perspective taking should positively influence knowledge integration.

Hypothesis 1: Wiki-induced cognitive elaboration positively influences knowledge integration.

² Although there are differences between knowledge and information, we did not differentiate them because those were not the focus of this paper. Moreover, the differences did not seem to impact the research model.

Knowledge Integration and Content Quality

Knowledge integration can improve wiki content quality because it helps leverage dispersed knowledge, which is essential for the successful accomplishment of content building (Tiwana and McLean 2005). Team members usually hold some unique knowledge. The accomplishment of team content building needs the collective efforts of team members because no one owns all the necessary knowledge to finish it. Thus, knowledge integration is crucial. The more knowledge is drawn, the more knowledge is integrated, and the more likely that teams can perform better and generate high-quality wiki content.

Hypothesis 2: Knowledge integration positively influences content quality.

Antecedents of Wiki-induced Cognitive Elaboration

Task Involvement

Previous works have provided some support for the impact of involvement on individual cognitive elaboration of information. For example, according to Park and Lee (2008), individuals tend to engage in thoughtful processing of product information when they have high product involvement. According to psychological research, individuals judge the credibility of another individual based on the processing of more information when they have high task involvement (Reinhard and Sporer 2008). Furthermore, De Dreu et al. (2003) argue that people are more motivated to process information when they are highly involved with the interpersonal negotiation task.

Extending this concept into the team context, we believe a team's task involvement can promote wiki-induced cognitive elaboration within the team. When team members are highly involved with the group task, they are more likely to have a strong desire to be accurate in completing the task. In order to achieve this goal, team members need to consider all perspectives, collect more task-related knowledge, and engage in deep, thoughtful cognitive elaboration of relevant information. They can accomplish these tasks using the wiki technology to facilitate their cognitive processing effort. Highly involved team members tend to exert more effort and energy in cognitive elaboration to fulfill their inner desire for accuracy in the project, and therefore, are more likely to engage wiki (and its functions) to facilitate their cognitive elaboration process. Therefore, a high level of task involvement is expected to lead to a high-level wiki-induced cognitive elaboration.

Hypothesis 3: Task involvement positively influences wiki-induced cognitive elaboration.

Process Accountability

With process accountability, team work and decision-making processes are observed and evaluated by others; moreover, members may be asked to explain and justify their decisions (Lerner and Tetlock 1999). Under high-process accountability conditions, team members are likely to be evaluated by others, and be asked to justify their decisions. Consequently, they are subject to potential criticisms (e.g., they may be criticized when they cannot explain or justify their work and decision-making processes) (De Dreu et al. 2000; Lerner and Tetlock 1999). In this situation, team members are more likely to engage in thoughtful cognitive elaboration, consider more decision alternatives, and gain an accurate understanding of the issue to justify their work processes better and avoid potential criticisms at the same time (De Dreu et al. 2000; Simonson and Staw 1992). In contrast, when process accountability is low and team members do not need to justify their decision-making and work processes, they are more likely to jump to conclusions without thoughtful consideration regarding relevant information (De Dreu et al. 2006).

Through laboratory experiments, previous works have also found that process accountability increases an individual's thoughtful information processing in the context of negotiation (De Dreu et al. 2006; De Dreu et al. 2000) and the group's thoughtful information processing in the context of group decision making (Scholten et al. 2007). In accordance, in the context of wiki-based teams, process accountability is viewed as having the ability to motivate team members to engage in cognitive elaboration using the wiki platform. Therefore, we hypothesize that process accountability influences wiki-induced cognitive elaboration.

H4: Process accountability positively influences wiki-induced cognitive elaboration.

Time Pressure

During a work process, teams may work under time pressure to finish the team task. Previous studies have shown that time pressure is an important factor influencing team processes and outcomes (Nordqvist et al. 2004; van der Kleij et al. 2009). Through experiments, researchers have also found that time pressure can reduce thoughtful information processing in an interpersonal negotiation context (De Dreu 2003; Van Kleef et al. 2004).

We believe that the time pressure faced by a team can reduce wiki-induced cognitive elaboration within the group. With high time pressure, team members are less likely to engage in cognitive elaboration, because it is time consuming and requires numerous mental activities. Instead, team members tend to be close-minded and jump to conclusions using heuristics, because they think this saves time and finishes the task quickly (De Dreu 2003; Van Kleef et al. 2004). Thus, we expect that the extent of using wiki for cognitive elaboration would be reduced in this situation. However, under low time pressure, team members may feel that they have sufficient time to conduct a project. In this case, they are more likely to take time and engage in cognitive elaboration by leveraging wiki technology. Therefore, we propose the following hypothesis:

Hypothesis 5: Time pressure negatively influences wiki-induced cognitive elaboration.

Critical Norm

Group norm is “a standard or rule that is accepted by members of the group as applying to themselves and other group members, prescribing appropriate thought and behavior within the group” (Postmes et al. 2001, p. 919). It serves an important regulatory function that can guide individual behavior in small groups (Baron and Kerr 1992). In a team with high critical norm, independence, and critical thoughts are promoted and valued, and team members tend to access and validate information critically and independently based on some objective standards (Postmes et al. 2001).

Previous research has found that when a high critical norm exists, team members value individually held information and tend to use it based on critical and rational considerations (Postmes et al. 2001). Similarly, when working on a project using wiki, team members under high critical norm should be more likely to think critically, appreciate and evaluate the knowledge shared by others, and analyze and assimilate them based on thoughtful information processing. Thus, critical norm is hypothesized to influence wiki-induced cognitive elaboration positively.

Hypothesis 6: Critical norm positively influences wiki-induced cognitive elaboration.

Task Reflexivity

Teams with high task reflexivity often review their objectives and team members are open to ways of improving their team’s work. Under this situation, team members are more likely to form the habit of reflexivity. They are more likely to think whether their groups are working correctly, and they evaluate other team members’ work, including their contributions to the wiki. Thus, high task reflexivity tends to promote wiki-induced cognitive elaboration.

Prior research also provides some support for this point. Through an experiment, van Ginkel et al. (2009) have found that team reflexivity can increase team members’ understanding of the importance of information elaboration in group decision making. The better team members understand the importance of cognitive elaboration, the more likely they would engage in cognitive elaboration. Similarly, De Dreu (2007) has argued that task reflexivity can promote team members’ motivation to systematically process information in teams. Thus, when working on projects using wiki, high task reflexivity is likely to increase team members’ emphasis on processing the wiki content, thereby facilitating cognitive elaboration.

Hypothesis 7: Task reflexivity positively influences wiki-induced cognitive elaboration.

Research Methodology

Instrument Development

The survey method was used to collect data for model testing. The instruments for measuring the latent variables in the model were first developed. Where available and to enhance validity, the measurement instruments of the constructs were adopted from previous research (Moore and Benbasat 1991; Stone 1978). Appendix A shows the measurement items and their sources. Through literature review, an initial item pool that contains relevant items used in the literature was generated. The items (e.g., the wordings of the questions) were adapted to our research context. To validate the adapted survey items, individual meetings with university colleagues and Ph.D. students were held to discuss the appropriateness of the questionnaire items, the possible ambiguities in the questionnaire items, and the appearance and layout of the questionnaire. Based on the feedback received, a revised questionnaire was developed, printed, and sent to five students for pre-testing.

Knowledge integration was measured using items adopted from Tiwana and McLean (2005). Wiki-induced cognitive elaboration was measured using items adapted from De Dreu (2003). The wordings of the items were revised to fit the context of the current research. For example, an original item, “I tried to take into consideration all possible perspectives,” was revised to “I tried to take into consideration all possible perspectives when working on the project using wiki.” Items related to time pressure were adapted from De Dreu (2003). Items related to critical norm were borrowed from Postmes et al. (2001). Items measuring process accountability were developed based on several research papers (De Dreu and van Knippenberg 2005; Gelfand and Realo 1999; Scholten et al. 2007; Zhang and Mittal 2005). These studies conducted laboratory experiments and provided manipulation check questions to measure process accountability. Items related to process accountability were developed based on these manipulation check questions. An original question, “I believed that I would have to explain the process of choosing to the researcher,” was revised to “We believe that we have to explain the work process to the lecturer/tutor.” Items measuring task involvement were adopted from the personal involvement inventory of Zaichkowsky (1994). Items measuring task reflexivity were adopted from the study by Tjosvold, Tang, and West (2004).

Empirical Setting

The samples were undergraduate students from a large university in Hong Kong. They attended a course on business applications of information technology (IT). The students were randomly assigned to small groups, with each group having four to six team members. By random assignment, individual differences and pre-existing social relationships between individuals were naturally controlled.

The students were told to investigate the IT applications of a chosen organization (e.g., a university, a firm, or other organizations). First, they chose and identified an organization and one of its IT applications. Thereafter, they analyzed and evaluated the effectiveness of the chosen IT application (e.g., the benefits or possible problems associated with the IT application). Finally, they proposed possible solutions to the problems that they have identified. The students were required to work as a team and to finish their reports using wiki. Given that the team members had high autonomy (e.g., work assignment and how to conduct the project), the situation cues they experienced were expected to vary. In total, the students were given 12 weeks to finish their task.

A commercial wiki service provider (<http://www.wikispaces.com/>) was chosen to support the works of the students. A tutorial regarding its usage was given to the students to improve their familiarity with the wiki system after the group tasks were assigned. Private Wikis³ for each group were created before the tutorial. All the teams were given the same wiki environment so that the variance on cognitive elaboration explained by technology is naturally controlled.

³ For private wikis, only the members of the wiki have the right to view and edit the wiki.

Data Collection

Two surveys were conducted at two different times. The first survey was conducted about three weeks after the tutorial. In the first survey, data on task involvement, time pressure, process accountability, critical norm, and task reflexivity were collected. Three weeks after the first survey, another survey was conducted to collect data on wiki-induced cognitive elaboration and knowledge integration. Collecting data at different times can overcome the issue of common method bias and allow causality reasoning.

Printed questionnaires were sent to all the students taking the course. Before the survey, they were told that their filled-out questionnaires would be kept confidential and would be used as an aggregate base only for the research. To motivate student participation in the survey, they were told that those who would participate in all the surveys would be given five bonus course marks. In each survey, 202 printed questionnaires were distributed. There were 138 usable samples from the students who participated in both surveys. The overall response rate was 68 percent. The respondents belonged to 46 different teams, a group-level sample size comparable with those reported in previous team level research (Kanawattanachai and Yoo 2007; Robert et al. 2008). On average, there are 3 subjects per team responded. The minimum and maximum value is 2 and 4 respectively.

Data on the quality of wiki content were obtained from the tutor's rating. After the students submitted their final reports, the tutor evaluated and scored the report of each team. The rating criteria were based on the quality, as well as creativity, consistency, and completeness, of the team report.

We controlled for the number of edits in the research model. We achieved this by counting the number of history pages, with each history page representing one specific version of edits. Its mean, minimum and maximum value is 40, 6, and 168 respectively.

Data Analysis and Results

The data were analyzed in three steps. First, analyses were conducted to justify data aggregation from the individual level to the group level. Second, the measurement model was examined. Third, the structural model was assessed to test the research hypotheses. Partial least squares (PLS) is a powerful component-based method that is widely used in literature (Wasko and Faraj 2005). In this work, SmartPLS (Ringle et al. 2005) was used to analyze the data.

Data Aggregation and Multicollinearity

Individual-level data were aggregated as group-level data. Some indices, namely, r_{wg} , ICC (1) and ICC (2), were used to support data aggregation for the shared group-level constructs (i.e., knowledge integration, task involvement, time pressure, process accountability, critical norm, and task reflectivity) (Klein and Kozlowski 2000).

r_{wg} is a widely used within-group agreement index developed by James, Demaree, and Wolf (1984). It reflects the extent to which the data obtained from unit members represent a consensus within the unit (e.g., a team) (Klein and Kozlowski 2000). The r_{wg} values were calculated for the variables in each team. The following average values were calculated: knowledge integration (0.96), process accountability (0.95), task reflexivity (0.92), critical norm (0.91), time pressure (0.82), and task involvement (0.85). All of these values are above the recommended value of 0.7 (Klein and Kozlowski 2000).

Aside from r_{wg} , other researchers have also suggested the use of Interclass correlations, namely, ICC(1) and ICC(2), to justify data aggregation (Bliese 2000). The following ICC(1) and ICC(2) values of the shared group variables were calculated: knowledge integration (0.23, 0.54), task reflexivity (0.26, 0.58), time pressure (0.18, 0.47), critical norm (0.22, 0.53), process accountability (0.24, 0.56), and task involvement (0.36, 0.70). These ICC(1) and ICC(2) values are comparable with the previous values reported in literature (Liao and Chuang 2004; Schneider et al. 1998). All the F-tests are significant ($p < 0.05$). In summary, the r_{wg} , ICC(1), and ICC(2) values all support the data aggregation employed in this paper.

The multicollinearity among the five antecedent variables was examined using the variance inflation factor (VIF) method. The VIF values range from 1.169 to 1.849, which are lower than the threshold value of 10 (Myers 1990). Thus, multicollinearity is not likely an issue in this study. We tested the potential common method bias (CMB) issue between wiki-induced cognitive elaboration and knowledge integration that are collected and tested at the same time. Harman's single-factor test (Podsakoff et al. 2003) was used to test CMB. A principal components analysis without rotation was performed on all the seven items, and two factors with eigenvalues larger than 1 were extracted, indicating that common method bias is not a major concern in this work as well.

Measurement Model

The measurement model was first assessed to achieve valid results. Its reliability, convergent validity, and discriminant validity, among others, were established. Construct reliability can be assessed by Cronbach's alpha and composite reliability; the recommended threshold value is 0.7. As shown in Table 1, all the Cronbach's alpha and composite reliability values are greater than 0.7, confirming the reliability of the measurement model. The measurement model exhibits convergent validity. First, as shown in Table 2, the average variance (AVE) extracted from the constructs exceeds the recommended threshold value of 0.5 (Fornell and Larcker 1981). Second, all items load significantly on their corresponding constructs; all loadings are above 0.7 (see Table 3). The measurement model also exhibits discriminant validity. First, as shown in Table 2, the square root of the AVE for the latent variables is larger than its correlation with the other constructs (Fornell and Larcker 1981). Second, the cross-loadings are lower than the item loadings on their corresponding constructs (See Table 3).

	Mean, standard deviation	AVE	Composite Reliability	Cronbach's Alpha
Critical norm	4.82, 0.64	0.78	0.91	0.87
Knowledge integration	4.76, 0.56	0.80	0.94	0.92
Process accountability	4.54, 0.54	0.68	0.89	0.86
Wiki-induced cognitive elaboration	4.77, 0.52	0.85	0.95	0.91
Time pressure	4.27, 0.72	0.88	0.94	0.88
Task involvement	4.15, 0.90	0.79	0.92	0.97
Task reflexivity	3.64, 0.45	0.69	0.90	0.85

	CN	KI	PA	PE	CE	TP	TR	TI
CN	0.88							
KI	0.64	0.89						
PA	0.58	0.57	0.82					
PE	0.37	0.46	0.23	1				
CE	0.52	0.52	0.31	0.13	0.92			
TP	-0.09	-0.25	0.11	-0.10	-0.18	0.94		
TR	0.53	0.55	0.36	0.19	0.55	-0.38	0.83	
TI	0.30	0.35	0.28	0.13	0.43	-0.02	0.33	0.89

Note: The values in the diagonal row are the square root of the average variance extracted. The others are the correlation coefficients between constructs. KI: knowledge integration; PA: process accountability; PE: team performance; CE: Wiki-induced cognitive elaboration; TP: time pressure; TR: task reflexivity; TI: task involvement.

Table 3. Items-loading and Cross-loadings									
Construct	Indicator	CN	KI	PA	PE	CE	TP	TR	TI
Critical norm	CN1	0.86	0.64	0.56	0.46	0.30	-0.04	0.51	0.25
	CN2	0.90	0.57	0.50	0.37	0.39	-0.15	0.52	0.23
	CN3	0.89	0.54	0.49	0.23	0.60	-0.05	0.42	0.29
Knowledge integration	KI1	0.67	0.87	0.60	0.41	0.54	-0.15	0.49	0.40
	KI2	0.51	0.89	0.50	0.44	0.41	-0.21	0.43	0.22
	KI3	0.57	0.93	0.46	0.41	0.51	-0.25	0.56	0.24
	KI4	0.54	0.90	0.46	0.39	0.39	-0.29	0.50	0.40
Process accountability	PA1	0.54	0.52	0.88	0.19	0.35	0.00	0.43	0.27
	PA2	0.50	0.49	0.88	0.14	0.29	0.08	0.23	0.23
	PA3	0.40	0.49	0.75	0.20	0.11	0.26	0.28	0.20
	PA4	0.40	0.38	0.77	0.33	0.14	0.26	0.16	0.23
Performance	PE	0.37	0.46	0.23	1.00	0.13	-0.10	0.19	0.13
Wiki induced cognitive elaboration	CE1	0.56	0.50	0.35	0.11	0.96	-0.06	0.55	0.48
	CE2	0.42	0.41	0.24	0.10	0.90	-0.12	0.48	0.35
	CE3	0.47	0.53	0.28	0.13	0.92	-0.33	0.48	0.36
Time pressure	TP1	-0.13	-0.29	0.05	-0.12	-0.20	0.97	-0.39	-0.01
	TP2	0.00	-0.15	0.21	-0.05	-0.12	0.91	-0.30	-0.03
Task reflexivity	TR1	0.36	0.44	0.29	0.05	0.39	-0.24	0.77	0.22
	TR2	0.41	0.46	0.20	0.12	0.37	-0.43	0.81	0.28
	TR3	0.47	0.57	0.34	0.26	0.53	-0.38	0.91	0.29
	TR4	0.51	0.37	0.33	0.15	0.49	-0.23	0.83	0.30
Task involvement	TI1	0.10	0.20	0.14	0.11	0.36	0.16	0.12	0.84
	TI2	0.38	0.47	0.43	0.17	0.42	-0.13	0.41	0.91
	TI3	0.29	0.25	0.16	0.06	0.38	-0.05	0.34	0.91

Structural Model

Figure 1 shows the results of the structural model analysis. The model explains 21.7 percent of the variance in wiki content quality, 27.5 percent of the variance in knowledge integration, and 42.7 percent of the variance in wiki-induced cognitive elaboration.

Hypothesis 1 posits that wiki-induced cognitive elaboration influences knowledge integration. In Figure 1, the path coefficient is 0.52 ($p < 0.001$), thereby supporting Hypothesis 1. Hypothesis 2 posits that knowledge integration positively influences content quality. In Figure 1, the path coefficient is 0.45 ($p < 0.01$), thereby supporting Hypothesis 2.

To test the mediating role of knowledge integration, we added a direct link of wiki-induced cognitive elaboration and content quality in Figure 1. We evaluated the model, and found that the direct effect of wiki-induced cognitive elaboration on content quality is not significant. Along with the significant effect of wiki-induced cognitive elaboration on knowledge integration, and knowledge integration on content quality, knowledge integration fully mediates the effect of wiki-induced cognitive elaboration on content quality (Baron and Kenny 1986).

The hypotheses on the antecedents of wiki-induced cognitive elaboration were tested. Hypothesis 3, which states that task involvement influences wiki-induced cognitive elaboration, is confirmed ($\beta = 0.25$, $p < 0.05$). The positive effect of the critical norm on wiki-induced cognitive elaboration is also supported ($\beta = 0.31$, $p < 0.05$), thereby confirming Hypothesis 6. Hypothesis 7, which states that task reflexivity influences wiki-induced cognitive elaboration, is supported ($\beta = 0.30$, $p < 0.05$). However, we did not find a significant impact of process accountability and time pressure on wiki-induced cognitive elaboration; thus, Hypotheses 4 and 5 are not supported.

The control variable (number of edit) also shows interesting results—it does not influence knowledge integration and wiki content quality significantly.

Discussion and Implications

Discussion of Results

This research helps understand how wiki-induced cognitive elaboration influence effective content building of wiki and its antecedents. In summary, the results show that wiki-induced cognitive elaboration does not influence content quality directly; instead, it influences content quality indirectly through its impact on knowledge integration. The number of edits does not have significant influence on knowledge integration and wiki content quality. We also run a rival model with number of edits as the sole antecedent of wiki content quality. Results show that it can only explain 1.9 percent of the variance in wiki content quality. This result agrees with our prior argument that it is the quality (wiki-induced cognitive elaboration) rather than the quantity (number of edit) aspect of wiki editing that matters to wiki team performance.

We find that wiki-induced cognitive elaboration is positively influenced by several key situation-specific variables, including task involvement, critical norm and task reflexivity, as confirmed through our hypotheses testing. Based on these findings, when the teams have high task involvement, critical norm and task reflexivity, they are more likely to have high wiki-induced cognitive elaboration.

However, we did not find a significant relationship between process accountability and wiki-induced cognitive elaboration. This observation is not consistent with that of prior research, which found significant relationships (De Dreu et al. 2006; Scholten et al. 2007). The mixed results may be explained by the fact that the teams in this study were not formally required to justify and explain their work processes. The teams had great autonomy in managing their work. Although some teams might have felt the need to justify their work processes, they were not required to engage in cognitive elaboration. Teams with high process accountability might have chosen the “right” work process, which team members might have thought could be justified and explained. Different groups had different understanding of what the “right” work process was. Thus, the work process they used may not highlight cognitive elaboration.

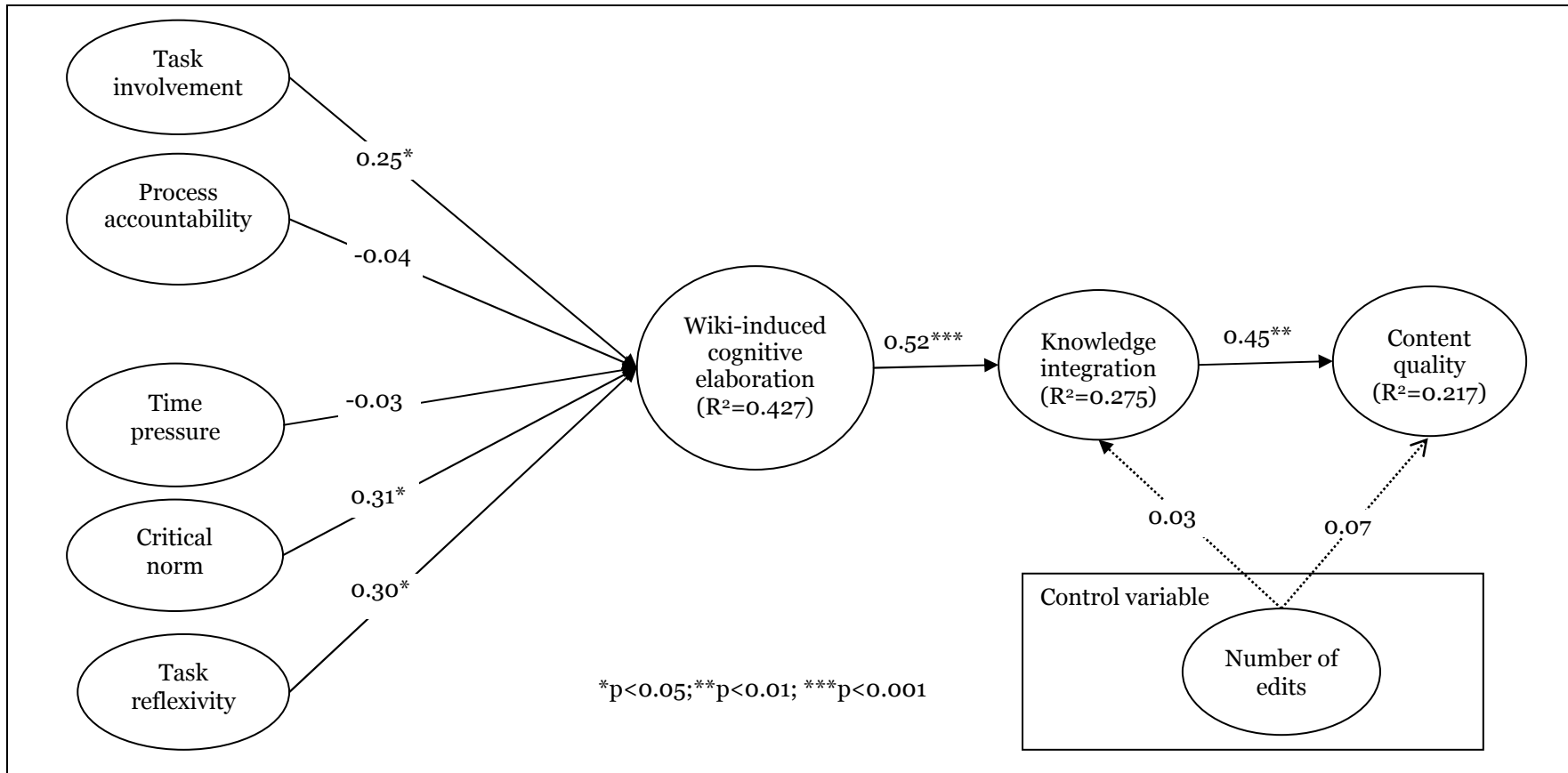


Figure 1. Research Model and Results of PLS Analysis

The impact of time pressure on wiki-induced cognitive elaboration is also not supported in this study. Based on the results, time pressure does not influence wiki-induced cognitive elaboration. However, prior research has found that time pressure can reduce people's systematic information processing during negotiation in the laboratory (De Dreu 2003). This observation may be explained by the fact that the team projects were relatively long-time tasks, and team members had high autonomy in managing their time. Hence, time pressure in real life teams may not be so salient. This result is different from that of the context of laboratory experiments in which time is rather limited. Another possible explanation is that time pressure in teams changes according to time. At the initial stage when time pressure data are collected, the team members may not feel the time pressure. Their perception of time pressure may increase at the latter stages when they already need to finish their projects. However, we tested the relationship using the time pressure data collected in the second survey (the same as when cognitive elaboration was measured). The impact on wiki-induced cognitive elaboration is also not significant. This result suggests that future research may be conducted to examine further the impact of time pressure on wiki induced cognitive elaboration.

Theoretical Implications

First, this study adds to our limited understanding of how wikis can be used for improving team performance by developing the new construct of wiki-induced cognitive elaboration and examining its impact on wiki team performance. We appropriate cognitive elaboration to the wiki context to capture the quality aspect of wiki collaboration, which advances the wiki literature that simply focuses on the quantity aspect of wiki usage, including the effect of wiki edit quantity (e.g., edit numbers and editor numbers) (Kittur and Kraut 2008; Wilkinson and Huberman 2007).

Second, this research identifies the path (the mediation of knowledge integration) through which wiki-induced cognitive elaboration can influence wiki team performance. This is an important finding particularly in light of the result that wiki-induced cognitive elaboration does not have a direct and immediate effect on content quality if knowledge integration were excluded from the research model. Our study thus highlights the indispensable role of knowledge integration in translating team members' cognitive effort to collective outcomes. In addition, our finding also contributes to the team knowledge integration literature by providing a new antecedent (wiki-induced cognitive elaboration), which complements prior works that have studied team knowledge integration from other perspectives, such as social capital (Robert et al. 2008), and formal interventions (Okhuysen and Eisenhardt 2002).

Third, we make a novel contribution to the IS literature by drawing on the motivated information processing theory (De Dreu 2007; De Dreu et al. 2003; De Dreu et al. 2000) to identify the team-based situational antecedents of wiki-induced cognitive elaboration. This theory, along with the situation-specific antecedents originating from this theory, is relatively new in the IS field. The explanatory power of the research model demonstrates the value of using this theory to predict wiki-induced cognitive elaboration.

Fourth, this research also contributes to motivated information processing theory, which originates from an interpersonal context, by extending its applicability to team contexts. Most of the previous works have been conducted using laboratory experiments to study information elaboration in interpersonal negotiation context (De Dreu 2003; De Dreu et al. 2006). Our study extends its generalizability, with adaptation, to the team context.

Lastly, this research demonstrates the positive impact of task reflexivity and critical norm on wiki-induced cognitive elaboration in teams. Although prior studies have argued that task reflexivity and critical norm can positively influence cognitive elaboration of relevant information, these factors were not tested empirically (De Dreu et al. 2006; De Dreu et al. 2003). The results of this research provide empirical support to their impact on wiki-induced cognitive elaboration.

Practical Implications

Our study advises managers that wiki-based team performance can be improved by promoting knowledge integration and wiki-induced cognitive elaboration. Wiki-induced cognitive elaboration is positively related to task involvement, task reflexivity, and critical norm. This observation suggests that managers should improve team members' task involvement, task reflexivity, and critical norm if they want to facilitate a team's wiki-induced cognitive elaboration. They can show the team members the importance of their projects, such as how much profit the project will bring in and how it is related to the strategic goals of their organization. This strategy can probably increase the involvement of team members with the project. The team leader or manager should periodically review the team's objectives and work processes. Based on the evaluation of and reflections on past work, they can make the corresponding adaptations to fit the work processes with the team's goals. This adaptation can promote task reflexivity, which positively influences wiki-induced cognitive elaboration in teams. Finally, team managers can also make rules that encourage and value critical thinking. This policy will enhance the critical norm of a team, which ultimately influences cognitive elaboration.

Limitations and Future Research

Some limitations of the current research should be considered. First, student teams in a university were used to collect data. There are differences between student teams and teams in firms; hence, caution must be observed when trying to generalize the findings of the present to other contexts, such as wiki teams in firms. Student teams were chosen because they allowed us to set up wikis for them and to study their knowledge integration using wikis. In addition, in using student teams, collecting data at different times was relatively easy. The dependent variables and independent variables were collected at different times; hence, our results were not influenced by the common method bias (Podsakoff et al. 2003; Podsakoff and Organ 1986). It also allowed us to employ causality reasoning. However, this design of collecting data in different times may bring potential problems, such as the change of the actual level of antecedents. In future research, work teams in firms can be used to collect longitudinal data and to test the research model.

Second, data were collected from Hong Kong, China. Caution must be observed when trying to generalize the results to other areas and countries. In general, the Eastern culture (e.g., Chinese culture) is characterized by collectivism, whereas the Western culture (e.g., American culture) is characterized by individualism (Earley 1989). Cultural differences may influence some of the relationships. For example, the impact of critical norm on wiki-induced cognitive elaboration is possibly stronger for teams in China compared with teams in America. Future research can study teams in Western countries and assess the influence of cultural differences.

Third, the measure for wiki-induced cognitive elaboration has room to improve, and future work can develop more refined items to measure this construct.

At last, drawing on previous research, e.g. Cress and Kimmerle (2008), alternative models can be developed to study the quality of wiki use and how to achieve superior team performance using wiki.

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Appendix A. Survey Items

Construct	Item	Source
Task involvement (TI)	<ul style="list-style-type: none"> I am very much personally involved with using wiki to complete the project (TI1). I think using wiki to complete the project is very important (TI2). Using wiki to complete the project is interesting (TI3). 	Adopted from Zaichkowsky (1994)
Time pressure (TP)	<ul style="list-style-type: none"> Team members feel they don't have sufficient time to finish the project (TP1). Team members feel to be under time pressure while finishing the project (TP2). 	De Dreu (2003)
Process accountability (PA)	<ul style="list-style-type: none"> We believe that we have to explain the work process to the lecturer/tutor (PA1). After finishing the project, we have to account for the way we finish it (PA2). We will be required to justify the way we finish the project (PA3). I feel accountable for the judgment and decision-making process during the project (PA4). 	Adopted from literature (De Dreu and van Knippenberg 2005; Gelfand and Realo 1999; Scholten et al. 2007; Zhang and Mittal 2005)
Critical norm (CN)	<ul style="list-style-type: none"> People in my team generally are critical (CN1). This is a critical team (CN2). In this team, you should think critically (CN3). 	Postmes et al. (2001)
Task Reflexivity (TR)	<ul style="list-style-type: none"> Our team often reviews the project objectives (TR1) The methods used by the team to get the job done are often discussed (TR2). Our team members are committed to ongoing improvement (TR3). Team members are open to improved ways of working (TR4). 	Tjosvold et al. (2004)
Wiki-induced cognitive elaboration (CE)	<ul style="list-style-type: none"> I tried to take into consideration all possible perspectives when working on the project using wiki (CE 1). I tried to make judgments and decisions as thorough as possible when working on the project using wiki (CE 2). I thought deeply before making a decision when working on the project using wiki (CE 3). 	Adopted from De Dreu (2003)
Knowledge integration (KI)	<ul style="list-style-type: none"> Members of this team synthesize and integrate their individual expertise at the project level (KI1). Members of this team span several areas of expertise to develop shared project concepts (KI2). Members of this team can clearly see how different pieces of this project fit together (KI3). Members of this team competently blend new project-related knowledge with what they already know (KI4). 	Tiwana and McLean (2005)

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