

Collaboration, intragroup conflict, and social skills in project-based learning

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Abstract This case study was conducted in two high school classrooms that utilized collaborative project-based learning (PBL). Collaboration is an important instructional strategy, especially used in conjunction with PBL, and is an essential learning outcome for the twenty-first century. This study examined how collaboration can be achieved as a learning outcome and used effectively as an instructional method by understanding what causes task-, process-, and relationship-related intragroup conflict and how social skills are related to intragroup conflict and collaboration at both the individual and group levels. Literature suggests that, while task-related conflict serves as a catalyst for collaboration, process- and relationship-related conflicts are detrimental to collaboration and impede learning. Social interdependence theory suggests that social skills play an important role in enhancing collaboration and resolving conflicts. Data were collected through online questionnaires and follow-up interviews. Interview data were analyzed using a qualitative data analysis approach. The survey data were analyzed using multi-level structural equation modeling, which allowed us to reveal an interesting relationship between group-level social skills and collaboration. Results suggest that different individual difference factors triggered each type of conflict, and most of the groups experienced more than one type of conflict simultaneously. Task and process conflicts were often transformed into relationship conflict, when social skills were lacking. Interestingly, group-level social skills were more influential than individual members' social skills in reducing intragroup conflict and enhancing collaboration.

Keywords Collaboration · Intragroup conflict · Social skills · Individual differences · Social interdependence theory

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Introduction

When entering the Information Age, a society requires different skill sets from people than in the Industrial Age (Reigeluth 1999, 2009; Toffler 1984; Friedman 2006). Developing networking skills, maintaining collaborative relationships with people, and making decisions as a team are considered essential skills to be successful in the new era (Collins and Halverson 2009; Reigeluth 1999; Partnership for 21st Century Skills 2011). These collaboration skills have been considered as an important learning outcome. For example, the U.S. Department of Education (2010) has recognized the importance of collaboration skills, and the International Society for Technology in Education has developed and published the National Educational Technology Standards for students, teachers, and administrators to nurture collaboration skills in students (1998). Therefore, educators need to understand how these skills can be developed and how instruction should be designed to develop them.

Collaboration is also an important instructional strategy, especially when used in conjunction with project- or problem-based learning (PBL). Collaborative PBL (CPBL) has been proposed as an innovative approach to engage students in an authentic project or problem, to allow students to drive their own learning through inquiry and to work collaboratively on projects (Hmelo-Silver 2004; Savery 2006; Nelson 1999; Bell 2010). CPBL is known to have many benefits, such as development of collaboration skills, improvement of critical thinking and creative thinking, complex problem solving, transfer of learning, and positive attitudes towards tasks (Johnson and Johnson 1989; Gokhale 1995; Bell 2010; Duch et al. 2001; Jonassen 2000, 2004; Savery 2006; Lee 2014).

The view that considers student collaboration as both a learning outcome and an instructional strategy led researchers to investigate not only how collaboration may increase learning outcomes—*collaborate to learn*—but also how collaboration can be learned—*learn to collaborate* (Littleton and Miell 2004). Collaborating to learn and learning to collaborate are two sides of the coin of collaboration. When students successfully learn how to better collaborate with one another, their intragroup process and the intra-individual learning process may be more effectively guided in acquiring knowledge (Littleton and Miell 2004; Dawes and Sams 2004; Järvenoja and Järvelä 2005, 2009). Conversely, poor collaboration with unresolved undesirable intragroup conflicts may impede their learning processes by preventing them from focusing on the learning task (Dawes and Sams 2004; Järvenoja and Järvelä 2005, 2009). For this reason, understanding the nature of collaboration can contribute to the knowledge base of how to enhance collaboration as a learning outcome and how to help learners better learn in collaborative projects.

Students in the high school where this study was conducted *learned to collaborate* and *collaborated to learn*. The teachers utilized CPBL as an instructional strategy, and they not only assessed students' subject content knowledge acquired through CPBL, but also assessed collaboration skills as a learning outcome. While the teachers perceived several benefits of CPBL discussed in literature, they shared with us that *intragroup conflict*, conflict arising among group members during collaboration, were the major challenge faced by the students and teachers in the implementation of CPBL. Järvenoja and Järvelä (2009) also reported that intragroup conflict created several social and emotional challenges during CPBL in their empirical study.

Our literature review suggests that there are three types of intragroup conflicts: task-related, process-related, and relationship-related conflicts. While task-related conflict acts as a catalyst for collaboration as Piaget's socio cognitive conflict does in collaborative

learning, process- and relationship-related conflicts negatively influence collaboration. In addition, group members' social skills are suggested as a variable that governs both collaboration and intragroup conflict in our literature review and data analysis. In this study, we investigated how collaboration can be better facilitated in the presence of intragroup conflict by understanding (1) what triggers each type of conflict, and (2) how social skills are related to collaboration and intragroup conflict at both the individual and group levels.

Conceptual framework and literature review

Collaboration is a specific type of social interaction and learning process in which group members can actively and constructively resolve socio-cognitive conflict in CPBL (Bender 2012; Bell 2010; Hmelo-Silver 2004; Savery 2006). While considerable attention has been given to the cognitive outcomes of collaboration based on Piaget's theory of socio-cognitive conflict (Dillenbourg et al. 1996; Littleton and Häkkinen 1999; Palincsar 1998), it was only recently that the social and emotional aspects of it have been studied (Lahti et al. 2004). Collaboration is a process in which group members not only interchange their knowledge, opinions, and ideas, but also share their feelings and emotions (Järvenoja and Järvelä 2005, 2009). In addition, collaborating on a project involves logistics in performing tasks, such as deciding on members' roles and responsibilities, group process, and so on. Therefore, it is natural for different types of conflicts other than socio-cognitive conflict to arise.

Types of intragroup conflicts

Intragroup conflict, the overarching concept for all types of conflicts among group members, can be broadly categorized into three types: (1) *task-related conflict*, (2) *process- or procedure-related conflict*, and (3) *relationship- or personality-related emotional conflict* (Pelled et al. 1999; Jehn 1997). These intragroup conflicts play an intervening role between individual differences and collaboration. Depending on what type of individual differences exists and how they play out in a group, different types of conflict arise, and each type of conflict has a distinct impact on collaboration (Jehn 1997; Pelled 1996; Pelled et al. 1999; Amason 1996). While task-related conflict has a positive impact on collaboration, the other two types of conflicts have negative impacts on collaboration. For example, Jehn and Mannix (2001) found that effective teams had low levels of process and relationship conflicts and moderate levels of task conflict in the midpoint in their longitudinal study.

Although the typology of intragroup conflict originated in management literature, the typology has been adopted in studying small group conflicts in psychology. Also, it is in line with intragroup conflicts that have been researched in education. For example, Lahti et al. (2004) observed small groups of pre-service teachers, and reported the three types of conflicts: "content-specific argumentation between different views and conceptions" (*task-related conflict*), "conflicts concerning responsibilities and the division of tasks" (*process-related conflict*), and "interpersonal issues" (*relationship-related conflict*) (p. 151). Furthermore, the typology can illuminate how the efforts of structuring and scripting collaboration in Computer-Supported Collaborative Learning (CSCL) help learners with the three types of conflicts.

Task-related conflict

Task-related conflict occurs when there are disagreements regarding a collaboration task (Pelled et al. 1999). This conflict type is in line with the concept of socio-cognitive conflict, as socio-cognitive conflict is defined as students having different answers to a question based on different perspectives (Dillenbourg et al. 1996). Empirical studies on task conflict have produced consistent results on their positive impacts on collaboration (Jehn 1997; Pelled 1996; Amason 1996; Jehn and Mannix 2001; Olson et al. 2007), unless they were highly associated with relationship-related conflicts (DeChurch et al. 2007; DeDreu and Weingart 2003). Like socio-cognitive conflict triggers intra-individual conflict, task conflict challenges individuals to rethink their ideas, coordinate, and collaboratively build their ideas. Pelled (1996) argued that task conflict “allows group members to test their ideas by exposing them to criticism” (p. 624) and thereby increases team performance. Supporting his argument, Amason (1996) found that task conflict was positively related to the decision quality of the team, cognitive understanding of the task, and affective acceptance among group members. Jehn (1997) also found a consistent result from her qualitative analysis of data from repeated interviews and on-site observations of conflict types in six work units in an organization. Effective groups had high levels of task conflict, and when the conflict appeared to be resolvable, group members were more motivated to solve them (Jehn 1997). Olson et al. (2007) also found that task conflict helped team members to better understand the task at hand, increased members’ commitment to the task, and improved decision quality.

Similarly, in their study of small groups of pre-service teachers, Lahti et al. (2004) found that task-related conflict served as a learning opportunity. Having contrasting views among group members led to the need for reconciling, which in turn engaged the members in explanation, argumentation, and coordination of their different views (Dillenbourg et al. 1996). According to socio-cognitive theory, this process promotes individual cognitive development, which makes possible more sophisticated participation by each individual, and in turn results in an enhanced level of collaboration (Dillenbourg et al. 1996).

While individual differences in academic abilities, achievement, perspectives, expertise and gender were reported as triggers for socio-cognitive conflict (Cohen 1994; Swing and Peterson 1982; Scariano and Davenport 1987; Damon 1984; Durfee et al. 1989), management literature adds its peculiar attributes of individuals that contribute to task-related conflict. Pelled (1996) hypothesized that job-related attributes, such as functional or departmental background, education, and organizational tenure, can trigger task conflict. People from different backgrounds may have different perspectives or opinions on a task. For example, engineers may focus on quality, while financial managers may emphasize cost and price.

Rather than expecting task conflict to emerge on their own from individual differences, researchers in CSCL have further investigated how to help learners engage in creation and negotiation of task conflict through argumentative knowledge construction (Weinberger and Fischer 2006; Weinberger et al. 2005, 2007; Dillenbourg and Jermann 2007; Häkkinen et al. 2010). For example, Weinberger et al. (2005) provided both an epistemic script, which was to prompt learners with questions related to the content, thereby creating relevant task conflicts, and a social script, which was to foster critical negotiation and avoid quickly reaching a false consensus.

Process-related conflict

Process-related conflict occurs when there are disagreements on the collaboration process, procedures, or responsibilities of group members rather than on collaboration tasks (Jehn 1997). Although process conflict has received relatively less attention in small-group research, several research studies highlight the importance of proper management of process conflict in collaboration, as it is as prevalent as the other types, and it has direct effects on team performance (Behfar et al. 2010). Unlike task conflict, process-related conflict was found to be detrimental to productive work processes and to have negative impacts on collaboration, especially when it regards responsibilities of members (Jehn 1997) and when it occurs in the early stage of collaboration (Greer et al. 2008). Jehn (1997) found that when a group intensively argued about who should do what, it took longer for the group to produce final outcomes, and group members often expressed dissatisfaction toward their group work. Also, in a longitudinal study, Greer et al. (2008) found that process conflict that emerged early in collaboration had negative and long-lasting impacts on collaboration and was associated with high levels of the other types of conflicts for the rest of collaboration, if not resolved at the beginning. These impacts were observed only for the process conflicts, not the task and relationship conflicts. Greer et al. (2008) have discussed about triggers for process conflicts in management literature.

In educational literature, process conflict manifests themselves as conflict arising from the division of tasks, management of responsibilities, and social loafing behaviors (Littleton and Häkkinen 1999). In their observation of groups of pre-service teachers, Lahti et al. (2004) reported that group members were often involved in heated discussion of task division, responsibilities, and commitment. Also, social loafing, which occurs when a group member avoids one's responsibilities, is a well-studied notion and a persistent problem reported during group projects (Karau and Williams 1993; Linnenbrink-Garcia et al. 2011; Johnson and Johnson 2009a).

In CSCL, scripts have been used as an approach for procedural scaffolding in collaborative learning by structuring group work process (Noroozi et al. 2013). Weinberger (2011) argues that specifying a sequence of activities and distributing roles can help learners better regulate their learning activities and facilitate knowledge building on the reasoning of their peers. For example, Häkkinen et al. (2010) assigned individual work to facilitate the group process and prevent social loafing by scripting collaboration. Also, Dillenbourg and Jermann (2007) defined a sequence of activities and specified individual roles. However, Dillenbourg and Jermann (2007) warned that overly structuring the collaboration process could disturb the natural problem solving process, and they reported that some students rejected the artificial linear process. Still, this procedural scaffolding can prevent group members from concentrating too much on undesirable process conflicts and help them effectively focus on content of the task.

Relationship-related conflict

Relationship-related conflict occurs when group members have an interpersonal clash with negative feelings between one another (Pelled et al. 1999). This type of conflict may appear as task conflict, but it stems from interpersonal relationship rather than from having different ideas on collaboration tasks. Relationship conflict interferes the process of knowledge co-construction, by making team members focus on negative emotions towards one another, making them more resistant to others' task-related ideas, and making it difficult

for members to process new or complex information, and thus negatively influence collaboration (Pelled 1996; Jehn 1997; Amason 1996). Jehn (1997) observed that expressed negative emotions led members to focus on the negative affect instead of their task. In contrast, one of the highest performing groups rarely expressed their negative feelings toward one another. Amason (1996) found that relationship conflict was associated with poor decision quality regarding the tasks, and members were more reluctant to accept other members' suggestions or opinions than groups without such conflict.

As sources of relationship conflict, visibly accessible individual differences such as gender, race, age, and functional background were reported as triggers for relationship conflicts in management literature (Pelled 1996; Pelled et al. 1999; DeChurch et al. 2007). The perceived dissimilarities may let members classify themselves and others into distinct social groups, and this cognitive process can trigger relationship conflict among members (Pelled 1996). Pelled et al. (1999) found that the more differences in tenure and race present in a group, the more relationship conflicts occurred in the group.

In educational literature, although relationship conflict has rarely been the focus of empirical studies, sources of emotions, emotional regulation, and their impacts on collaboration have been studied at the individual and group levels (Wosnitza and Volet 2005; Linnenbrink-Garcia et al. 2011; Järvenoja and Järvelä 2005, 2009). Especially, Järvenoja and Järvelä (2009) reported that teacher education students experienced relationship conflict that originated from incompatible work styles during small-group projects. Furthermore, they found that group members engaged in self and shared regulation of their emotions. That is, group members were actively regulating their emotions on their own and together as a team. This offers an explanation of the negative findings of Jehn (1997) and Amason (1996). Although negative emotions arise, when the emotions are regulated within self or among group members, relationship conflict may not emerge. However, when negative emotions are not successfully managed but are crudely expressed, relationship conflict arises.

Relationships among task, process, and relationship conflicts

Although the three types of conflicts have shown distinct impacts on collaboration, they seem to interact with one another. Based on early findings of Pelled et al. (1999) and Jehn (1997), emphasis has been placed on the interrelationships among the three conflict types. Jehn (1997) suggested that task and process conflicts also contain emotions to some extent. Having task conflicts enhanced collaboration, yet Pelled et al. (1999) reported that task conflict was a significant predictor of relationship conflict, which was detrimental to collaboration. Consistently, strong correlations were observed between task and relationship conflicts in a meta-analysis (DeDreu and Weingart 2003; Behfar et al. 2010). That is, excessive arguments on task-related issues can result in relationship conflict.

Likewise, Greer et al. (2008) found that process conflict generated negative emotions and transformed into relationship conflict. Similarly, Behfar et al. (2010) found high correlations between process and relationship conflicts. One can reason that process conflict can trigger relationship conflict, as arguing who does what can accompany negative emotions. Relationship conflict can impede positive influence of task conflict on team performance by stymieing constructive discussion among group members and by making members focus on negative emotions.

Also, Linnenbrink-Garcia et al. (2011) found that fourth- and fifth-grade group members with negative emotions displayed more social loafing behaviors in their study. This indicates that relationship conflict can trigger process conflict. As each conflict type transforms into or triggers another conflict type that has detrimental effects, empirical research has

been focused on what moderates conflict transformation, particularly on what prevents task conflict from transforming into relationship conflict. Moderators reported as effective in empirical research can be broadly categorized into intragroup trust (Peterson and Behfar 2003; Simons and Peterson 2000) and conflict management strategies (Alper et al. 2000; DeChurch et al. 2007). Simons and Peterson (2000) found that intragroup trust played a key role in preventing conflict transformation and capitalizing on task conflict. Intragroup trust also moderated the relationship between other conditions and conflict transformation. For example, Peterson and Behfar (2003) found that negative performance feedback on the previous group work results in increases in both task and relationship conflict, but this link was weak for the groups with high trust.

A collaborative conflict management approach was reported to reduce conflict transformation compared to a competitive approach (DeChurch et al. 2007; Alper et al. 2000). Collaborative approaches emphasize reaching mutual goals, understanding everyone's views, and incorporating several ideas to find a solution, whereas competitive approaches create a win-lose situation and let different ideas compete with one another rather than incorporating them (Alper et al. 2000). Alper et al. (2000) found that collaborative approaches led to an increase in the team's belief in their effective conflict management ability, which resulted in successful team performance.

DeChurch et al. (2007) expanded management approaches to five styles based on two dimensions: agreeableness and activeness. The five styles are collaborative (high on both dimensions), competing (low agreeableness yet high activeness), accommodating (high agreeableness yet low activeness), avoiding (low on both), and compromising (moderate on both). They manipulated conflict management styles of 135 dyads who were randomly assigned to the five conditions and given the same task. The results suggest that how task conflicts are managed influences subsequent relationship conflict, and among the five types, the collaborative condition generated the least and the competitive condition produced the most relationship conflicts.

Social skills

While of some utility, scripting and structuring collaboration may not always be feasible in CPBL. Whereas collaboration scripts originated from the scripted cooperation approach (Häkkinen et al. 2010), the group process of CPBL is multifaceted, complex, dynamic, and often not a linear progression. While engaging in a long-term, open-ended CPBL project, members face new responsibilities and topics that emerge spontaneously. Therefore, a different approach was warranted to effectively manage intragroup conflict that can better accommodate the emergent, dynamic learning process. From social interdependence theory we identified social skills as a mediating factor between intragroup conflict and collaboration that has not been empirically examined.

Social interdependence theory identifies social skills as one of the five variables that mediate collaboration because it helps members resolve conflict and makes collaboration effective (Johnson and Johnson 2009b). The authors proposed that appropriate use of social skills lets members communicate accurately and resolve conflicts constructively, and accordingly impacts collaboration positively (Johnson and Johnson 2009a). Although there is a paucity of literature regarding social skills in relation to conflict and collaboration, a few experimental studies have examined the impact of social skills on collaboration (Gillies and Ashman 1996; Prichard et al. 2006a, b).

Putnam et al. (1989) compared a group with the teacher's instruction on social skills and a group without such. As a result, the group that was taught social skills had more positive

relationships among one another, suggesting that members' appropriate use of social skills may prevent relationship conflict and have a positive impact on collaboration in a group by helping members constructively resolve conflicts on task, process, and relationship.

An experimental study conducted by Archer-Kath et al. (1994) examined which is more effective, group feedback or individual feedback on social skills, in increasing motivation and academic achievement. It was found that individual feedback on social skill performance increased motivation and academic achievement, and individual feedback resulted in more positive relationships among group members and positive attitudes toward the content, teacher, peers and themselves.

Results were consistent. Groups that received training on social skills obtained higher performance scores and collaborated better than untrained peers. However, interestingly, this benefit was lost when trained students were regrouped (Prichard et al. 2006a, b). In conclusion, appropriate use of social skills can help members resolve conflicts in a way that enhances collaboration. However, the effects of training social skills did not last when members were regrouped.

Summary and knowledge gaps

Figure 1 summarizes our review of literature. Individual differences among group members trigger various types of intragroup conflicts, including task, process, and relationship conflicts. These conflicts impact student collaboration. Social skills of individual members mediate the collaboration process by intervening between intragroup conflicts and collaboration.

Table 1 summarizes types of conflict, triggers, and impact of each type of conflict. Task conflict stimulates members' thinking by making them explain, argue, and negotiate their positions, while members are coordinating their opinions on the task and engaging in argumentative knowledge construction, and these behaviors positively affect individual learning and team performance. Functional, departmental, and educational backgrounds may translate to different expertise and perspectives, and organizational tenure might be interpreted as different levels of academic or professional ability or perspectives, considering the different settings and subjects in the education and management literature. In contrast, process and relationship conflicts are reported as negatively affecting team performance. While triggers for process-related conflict were not reported, visibly accessible attributes of members, such as gender, age, tenure, race, and functional background as well as incompatible work styles and personalities were reported as triggers for relationship conflict.

Research questions

Although management literature provides some information about what triggers task and relationship-related conflicts, some causes of conflict may be inapplicable to situations in secondary education. For example, in high school classrooms not much difference exists in

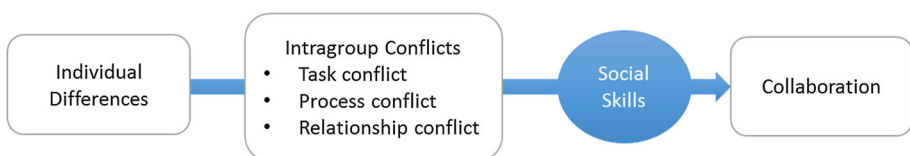


Fig. 1 Collaboration model based on Piaget's theory of socio-cognitive conflict

Table 1 Types of conflict and their triggers

Types of conflict	Individual differences triggering conflicts	Impact
Task	Academic achievement/ability (Edu)	Positive
	Expertise/perspective (Edu)	
	Functional or departmental background (Man)	
	Education background (Man)	
	Organizational tenure (Man)	
Process	Not reported	Negative
Relationship	Gender, age, tenure, race, functional background (Man)	Negative
	Incompatible work styles and personalities (Edu)	

Edu reported in educational literature, *Man* reported in management literature

age and often even in educational backgrounds, nor in functional backgrounds. Also, little is known about causes of process-related conflict. Therefore, exploratory research on causes of each type of conflict in a high school classroom is warranted.

Also, social skills seems like a promising factor that mediates intragroup conflict, and it seems very promising to utilize social skills as a mediating factor to positively resolve conflict and enhance collaboration. However, little research has been conducted to investigate relationships among the three factors: intragroup conflict, collaboration, and social skills in a natural setting at both individual and group levels. This research study addresses the knowledge gaps by answering the following two research questions:

1. What individual difference factors trigger each type of intragroup conflict in CPBL in high school classrooms?
2. How does social skills impact intragroup conflict and collaboration during CPBL at individual and group levels?

Methods

Research design

This case study utilized survey research methods using an online questionnaire and follow-up interviews with students. A questionnaire was administered to students in order to measure levels of intragroup conflicts, collaboration, and use of social skills of group members after their completion of group work. Sixteen follow-up interviews were conducted to explore triggers for each type of conflict with group members who reported any types of conflict. In order to answer each of the research questions, the following approaches were used: (1) qualitative analysis of the interview data for the first question about triggers for each type of conflict, and (2) multi-level structural equation modeling (SEM) for the second question about relationships among the three factors.

Settings

This research was conducted in a natural setting: two American studies classrooms in the high school in a small city area of the United States. American studies is an interdisciplinary subject that combines American history and English language arts. Two teachers

co-taught the subject, utilizing CPBL. The class met twice a week for one and a half hours each meeting. In the classroom, there was a one-to-one student–computer ratio, and members in a group gathered together so that they could discuss any issues during a project. There was a conference desk in the center of the classroom and two conference rooms outside in which group members could hold a meeting. There were usually 10 projects in an academic year. Each project typically lasted 2–6 weeks. A group of two to five students collaboratively worked on a project.

Projects

Data were collected over three projects: two projects in one classroom and a third project in another classroom. All three projects had two major phases: (1) planning, in which group members collectively decided on the content and format, and (2) production, in which they developed their final product.

For each project, the teachers provided an entry document that introduced the topic of the project, group contracts, benchmarks with to-do lists, instructional resources, and rubrics upon which student performance was evaluated. In each project, students completed a group contract, in which they identified each group member's strengths and set group rules and norms at the beginning of their group work. Each project had several benchmarks along the way, and students needed to turn in specific deliverables at each benchmark. Students were graded based on the quality of their final product on a group basis, individual understanding of content, individual collaboration, oral and written communication skills, and work ethic.

Project 1

The first project was for each group to create an instructional piece on Jim Crow for digital learners for 4 weeks. After learning about Jim Crow, students selected 3–5 major topics about Jim Crow on which they wanted to create an instructional piece such as stereotypes, general racism, media, and Jim Crow merchandise, and chose any technology tools to develop the instruction. Forty-six students were grouped into 13 groups.

Project 2

The second project was to create a presentation on one of the themes of the novel, *To Kill a Mockingbird* (TKAMB), for 3 weeks. After students finished the novel, each group of students selected a theme from the novel, such as racism and prejudice, the importance of education, social inequality, and so on, and created a presentation using whatever technology tools they wanted on the selected theme. Forty-five students were grouped into 17 teams.

Project 3

The third project was to create a web page on Martin Luther King, Jr. (MLK, Jr.) for 5 weeks. After learning about Martin Luther King, Jr., each group of students selected a topic, such as his biography, a speech, or opposition to the Vietnam war, and created a web page about their topic using a web-based website building tool. Sixty-five students were grouped into 25 groups.

Participants

Participants were 111 students from 9th and 10th grades (14–16 years old) in the two American studies classrooms. The students were homogeneous in terms of their ethnic and racial backgrounds except for a few Asian-American and African-American students. Sixty-five percent of students were male.

Procedures

Students were grouped based on their answers to a question formulated by their teachers. These questions were generally concerned with student interests in different aspects of the projects. For example, in the case of Project 1, the teachers identified main broad topics related to Jim Crow, and students who chose the same topic were grouped together. Once the groups were formed, the group members decided on and documented their norms, rules, and group members' roles and responsibilities on the group contract provided by the teachers.

During the projects, the group members worked collaboratively and individually. They made important decisions regarding their project together, distributed work to individual members, and each member worked on the assigned part of the project. Teachers provided related resources, suggestions, and support during their group work. After students completed their projects, they presented their outcomes to the class and sometimes to an audience outside their class.

Upon finishing each project, participants completed an online questionnaire regarding their intragroup conflicts, social skills, and collaboration. Students who reported any type of intragroup conflict were identified from the online questionnaire, and the 16 students who agreed to participate in a one-on-one interview were interviewed individually.

Data collection

Data were collected over the three projects using the online questionnaire and one-on-one follow-up interviews.

Online questionnaire

We collected data through the online questionnaire to measure the three constructs (intragroup conflict, social skills, and collaboration). Based on a literature review, the online questionnaire was created, and was reviewed by an expert to ensure the appropriateness of the items for each construct and improve its construct validity. Six pilot tests were conducted with graduate students to prevent any measurement or processing errors (Groves et al. 2009). In order to check construct validity of the items, confirmatory factor analyses of the three constructs were performed (Thorndike and Thorndike-Christ 2010).

Three constructs were measured on a 7-point scale through the online questionnaire. Their operational definitions and instruments used are described below. To see the full instruments, the reader is referred to the [Appendix](#).

Intragroup conflict Intragroup conflict is defined as any type of conflict or disagreement experienced among group members. Based on our literature review, we identified three types of conflict: task-, process-, and relationship-related conflict. Therefore, at the end of each project, participants were asked to provide frequency of each type of conflict in their

team on a 7-point scale from *Never* to *Always*. We used the word disagreement instead of conflict because of the negative connotation of the word, conflict.

Social skills In order to operationally define social skills, Riggio's six dimensions (1986) were adopted. Riggio (1986) defined social skills as non-verbal and verbal interpersonal skills that govern social interaction. He identified six dimensions of social skills: emotional expressivity, emotional sensitivity, emotional control, social expressivity, social sensitivity, and social control. The first three dimensions refer to nonverbal skills to express one's emotions (*emotional expressivity*), to receive and decode others' emotions (*emotional sensitivity*), and to regulate one's emotions (*emotional control*). The last three dimensions are related to verbal skills. *Social expressivity* refers to a verbal speaking skill to engage others in social interaction. *Social sensitivity* is the ability to understand verbal communication and general awareness of the group norms governing appropriate social behavior. And those who are high in *social control* are able to adjust their behavior to fit with what they believe to be appropriate in the social context.

Riggio's six dimensions were revised to seven social skills (see Table 2) in order to be comprehensible to the participants within the context of the study: communicating one's ideas, listening to others, open-mindedness, empathizing with other group members, appreciating others' beliefs and responsibilities, adjusting one's behaviors to the group's norms and rules, and resolving conflicts among group members. All participants were asked to rate competency of their individual group members and themselves on the seven social skills on a 7-point scale from *Extremely poor* to *Extremely good*.

Collaboration Dillenbourg's (1999) three unique characteristics of collaboration were used to measure levels of student collaboration: interactivity, synchronicity, and negotiability. *Interactivity* is defined as the extent to which interactions among group members influence each other's cognitive processes, not by the frequency of interactions. *Synchronicity* entails synchronous communication, which involves mutual reasoning processes (Dillenbourg 1999). Communication in collaboration is more synchronous than in cooperation. Dillenbourg (1999) warned that the concept of synchronicity should not be interpreted as the same meaning by which we characterize communication tools as synchronous or asynchronous. Whereas communication tools are categorized based on how long a delay exists between responses, synchronicity in collaboration refers to the process of reasoning occurring simultaneously. *Negotiability* is the extent to which one can argue for one's position and influence the group's work process and outcome (Dillenbourg 1999).

Table 2 Social skills survey items based on Riggio's six dimensions

Riggio's six dimensions	Survey items of social skills
Emotional expressivity	SC1: Communicating one's ideas
Social expressivity	
Emotional sensitivity	SC2: Listening to others
	SC3: Open-mindedness
Social sensitivity	SC4: Empathizing with other group members
	SC5: Appreciating others' beliefs and responsibilities
Emotional control	SC6: Adjusting one's behavior to the group's norms and rules
Social control	SC7: Resolving conflicts among group members

Unlike in a hierarchical situation, in collaboration, a member’s opinion would not be imposed on other members, although the member would argue for her opinion and attempt to convince others. This characteristic allows a socio-cognitive conflict or task conflict to be resolved through synchronous communication.

Those three characteristics appear as frequent discussion and negotiation. Seven questions were formulated for the online questionnaire as shown in Table 3, and they were asked on a 7-point scale from *Strongly disagree* to *Strongly agree*.

A total of 181 students was asked to complete the online questionnaire, and 156 of them did so. Among the completed questionnaires, 3.18 % were missing values with a monotone pattern, which refers to the situation where a variable is missing for a particular individual subject, and all subsequent variables are missing for that individual (SAS Institute n.d.). The missing values were imputed by averaging at least two other group members’ data for the group, if available. Cases that had less than two group members’ data available were list-wise deleted. As a result, 5 cases were deleted, and 151 observations within 53 groups remained for data analysis. Results for each research question are discussed in the following section. Table 4 summarizes the numbers of participants and questionnaires completed. It should be noted that the same students from Classroom 1 were regrouped and participated in a second collaborative project. This violates the assumption of independence of observation, which can influence the probabilities of committing Type 1 and Type 2 errors and, thereby, either falsely detects a significant difference or fails to detect such a difference that actually exists (Scariano and Davenport 1987). However, the two constructs, collaboration and intragroup conflicts, are group-specific rather than individual-bounded. Therefore, we believe that the violation would not significantly influence the analysis.

Table 3 Instruments for collaboration

Item	Question
CB1	I have often engaged in discussion with one or more group members about the project
CB2	Discussion in my group stimulates my thinking
CB3	Everyone’s ideas and opinions have been considered by our group
CB4	Everyone’s ideas and opinions have been incorporated into our final deliverables when appropriate
CB5	My group has engaged in discussion when we have to make a decision
CB6	My group has developed ideas together as a team
CB7	My group has continued discussion until we reached consensus when we had to make a decision

Table 4 Number of participants and questionnaires completed

Classroom	Participants	Project	# of groups	Questionnaires completed	Questionnaires used
#1	46 ^a	1. Jim Crow	13	46	46 (13 groups)
		2. TKAMB	17	45	45 (17 groups)
#2	65	3. MLK, Jr.	24	65	60 (23 groups)
Total	111		54	156	151 (53 groups)

^a Students were re-grouped for the TKAMB project

Interviews

Sixteen interviews were conducted. Interviewees were selected by reviewing responses on the online questionnaire. Thirty-seven of the 53 groups who participated in the survey reported some type of conflict on the questionnaire. Table 5 presents a summary of groups that reported intragroup conflicts. We reviewed the responses to open-ended questions about conflicts; we found that there are some groups that reported more than one type of conflict. Based on our reviews, we identified the most frequently reported type of conflict reported by each group. There were very few groups that experienced process conflicts. We interviewed 16 students from eight groups who volunteered to be interviewed. These eight groups were among the 11 groups that performed the TKAMB project and reported intragroup conflicts. This cohort had all three types of intragroup conflicts, whereas the other two cohorts reported only two.

Table 6 presents numbers of members who participated in interviews and total numbers of members of each group. There were two groups (Group 4 and 5) for which all of their members participated in the interviews. There were three groups (Group 1, 2, and 3) for which more than half of their members were interviewed. In Groups 6, 7, and 8, less than half of their members participated in the interviews.

Every group member who reported conflict and agreed to participate (a total of 16 students in eight groups) was interviewed individually and was asked the following questions to answer research question 1:

- What kinds of conflicts or disagreements occurred in your group?
- What caused those kinds of conflicts or disagreements?—Prompt for the following if necessary: different areas of expertise, personalities, and knowledge levels.

Of the 16 interviews, 14 were audio-recorded with the interviewees' permission and transcribed verbatim. The interviewers took notes on the two interviews for which

Table 5 Summary of groups reported intragroup conflicts on questionnaires

Project	Total # of groups	# of groups reported conflicts	Breakdown of major conflict type	
1. Jim Crow	13	9	Task	5
			Process	0
			Relationship	4
2. TKAMB	17	11	Task	6
			Process	1
			Relationship	4
3. MLK, Jr.	24	17	Task	15
			Process	0
			Relationship	2
Total	54	37		

Table 6 Numbers of interviewees from each group

Group ID #	#1	#2	#3	#4	#5	#6	#7	#8	Total
# of interviewees	2	2	3	4	2	1	1	1	16
# of members	3	4	4	4	2	4	3	3	27
Participation %	67	50	75	100	100	25	33	33	59

permission to audio-record was not granted. Two volunteer interviewers were trained on the purpose of the study, research questions, and interview questions. Each of the volunteer interviewers was paired with one of us, and each pair conducted the first two interviews. A single interviewer conducted the other 14 interviews.

Data analysis

RQ1: What individual differences influence each type of intragroup conflict?

In order to explore the causes of each type of conflict, interview data were reviewed and segmented by the principal researcher. After segmentation, we assigned codes that were identified through the literature review.

Another researcher reviewed the segmented data and assigned codes independently. He was allowed to come up with new codes. After completion of independent coding, the codes were compared with the ones by the principal researcher. For the conflict types, two units out of 25 were differently coded. For the causes, six units out of 25 were differently coded. The two researchers revisited the related interview transcriptions, discussed their rationale and the definitions of the codes, and reached consensus on the final codes. Table 7 presents descriptions of the codes.

Answers were also reviewed for the open-ended questions from the online survey, such as “Please describe any disagreements or conflicts that occurred in your team during the project. What triggered those conflicts or disagreements you mentioned in the previous question?” We could identify types of conflicts from the answers, but the answers were not descriptive enough to identify causes of conflicts.

RQ2: How does social skills impact intragroup conflict and collaboration?

Research question 2 involves three factors with multiple indicators. Multi-level structural equation modeling (SEM) was performed because it allows one to test relationships among multiple factors measured by multiple observed variables with clustered data around groups and to investigate the factors at both the individual and group levels simultaneously (Bollen 1989; Kaplan 2009; Kline 2011).

An SEM model was constructed as in Fig. 2. In SEM, there are a measurement part and a structural part in the model. In our model, there are three measurement parts wherein each factor is measured by multiple indicators: conflict is measured by three indicators, and

Table 7 Descriptions of codes for causes of conflict

Code	Description
Perspectives	Different points of view, opinions, ways, minds, ideas, and perspectives were merged into <i>perspectives</i>
Interests	When special attention to a topic or object was mentioned, it was coded as <i>interests</i>
Personality	When different characteristics or personalities of people were mentioned, it was coded as <i>personality</i>
Social loafing	When a person was off task or was on a project-unrelated task, it was coded as <i>social loafing and individual accountability</i>
Social skills	Not listening, insisting on one’s own ideas and blocking others’ ideas were merged into social skills

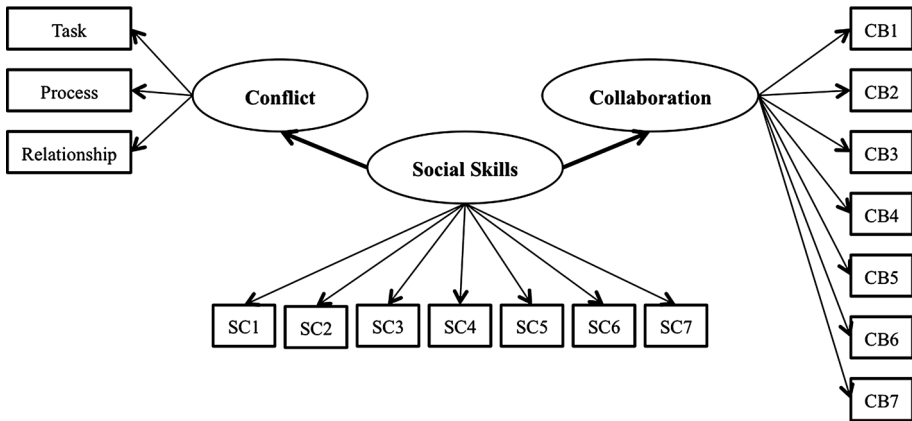


Fig. 2 Hypothesized model

social skills and collaboration are each measured by seven. The structural part refers to the relationships among the three factors.

In the structural part, we hypothesized that social skills impacts both conflict and collaboration. Our literature review suggests that appropriate uses of social skills facilitate collaboration. In addition, from our interview data, we found that lack of social skills is related to intragroup conflict.

Because of the small sample size, the following approach was used. First, we validated the measurement parts of the model using a multilevel confirmatory factor analysis (CFA). Given satisfactory results, items for each factor were averaged into one value in order to test the structural part of the model using multi-level path analysis with a small sample size having a sufficient power level. This approach is a type of the parceling approach described by Little et al. (2002).

Three sets of multi-level CFA were conducted for each of the three constructs: social skills, intragroup conflict, and collaboration. The model fit was evaluated by the following criteria: non-significant Chi square *p* value, RMSEA ≤ 0.05 , CFI ≥ 0.95 , and TLI ≥ 0.95 (Bollen 1989; Kaplan 2009).

Table 8 presents model fits of each of the measurement parts. The model fit indices suggested a good fit. Chi square *p* values were larger than .05, CFIs and TLIs were larger than .95, and RMSEAs were smaller than .05.

Table 8 Model fit of the measurement parts

	Social Skills	Conflict	Collaboration
Chi square test			
Value	34.833	1.765	33.216
df	35	3	31
<i>p</i> value	0.4761	0.6226	0.3597
CFI	1.000	1.000	.997
TLI	1.000	1.008	.997
RMSEA	0.000	0.000	0.022

Based on the results of the multi-level CFA, we concluded that the items sufficiently well measure the three constructs for corresponding items to be combined, and we proceeded to the multi-level path analysis with averages of the items for the three constructs.

Results

RQ 1: What individual differences influence each type of intragroup conflict?

Analysis of interview data revealed student perceptions about what kinds of individual differences contributed to each conflict type, how more than one conflict type occurred simultaneously, and how lack of social skills transformed a task conflict to a relationship conflict.

Groups experienced more than one type of conflict during the projects

Table 9 presents the types of intragroup conflict reported in the eight groups that participated in the interviews. Five out of the eight groups experienced multiple types of conflict simultaneously, according to the interview data: four groups with all three types of conflict, two groups with task and relationship conflicts, one group with only relationship conflicts, and another group with only task conflicts. Given that only few members from Groups 6, 7, and 8 participated in interviews, it is highly probable that there was limited and biased information provided by the interviewees. Supporting this argument, in the survey responses, we could find evidence of task conflicts in addition to relationship conflicts in Group 6 as well. Therefore, most of the groups experienced more than one type of conflict during group projects.

The survey data agreed with the results. Respondents who reported any type of conflict in the survey questions on conflicts gave similar ratings across all three types of conflict, which means they experienced all the types of conflict at some level. According to the available responses from open-ended survey questions, 13 groups out of 37 that reported any type of conflict experienced more than two types of conflict at the same time: five groups experienced all three types of conflict; four groups experienced process and relationship conflicts; three groups experienced task and relationship conflicts; and one group experienced task and process conflicts. Whereas task and process conflicts rarely occurred simultaneously, process and relationship conflicts as well as task and relationship conflicts often occurred together.

Table 9 Groups that experienced intragroup conflicts (from interview data)

Group ID #	#1	#2	#3	#4	#5	#6	#7	#8
Task	√	√	√	√	√	√	√	√
Process	√	√	√	√				
Relationship	√	√	√	√	√	√	√	
Total	3	3	3	3	2	1(2)	2	1

√ and √ indicate presence of corresponding type of conflict in groups from interview data and survey data respectively

Task conflict: differences in perspectives and interests

All eight groups reported that they experienced some sort of task conflict, according to interview and survey data. Table 10 presents triggers for task conflict. Task conflicts could be broadly categorized into two sub types: content (what content to put in their final products) and format (what format or media to use for presenting their content). Four groups reported task conflicts on content, two groups reported task conflicts on format, and one group reported both.

These task conflicts seemed to be triggered by disagreements that stemmed from different interests (number of occurrences = 3) and perspectives (number of occurrences = 6) of the members. Because the students were grouped based on their interests, there were fewer cases of task conflicts triggered by members having different interests.

Bill and his group member (Group 2) showed an example of a task conflict on content stemming from different interests and perspectives. His partner wanted to have weapons as their topic, but Bill disagreed: “I think he was just more interested in that aspect. He wanted to study, he wanted to talk about weapons, but how are you going to make weapons sticky in a video?” His partner’s interest in weapons and his perspective on how to make weapons sticky resulted in task conflict.

Lucy and her partner (Group 5) showed a task conflict on format stemming from different perspectives. They had different ideas on which format to use for their product between a video and a poem. Lucy argued, “A video could be a better idea, because people like something visual, like watching video instead of reading a poem.” Her partner insisted, “A poem can have more impact, explaining what’s going on, instead of video.” Lucy and her partner had different perspectives on which is more important between attracting people’s attention and explaining the content.

Process conflict: social loafing

There appeared unique patterns of process conflict that are different from Jehn’s study (1997). In her study, process conflicts centered on the procedure, roles, and responsibilities during the project. However, in this study, process conflicts occurred when some group members did not live up to their responsibilities and displayed social loafing behaviors. Four groups out of eight reported process conflicts together with task and relationship conflicts. Triggers for the process conflicts were social loafing. Ted from Group 1 explained, “...The problem was he was off task. He wasn’t going to do his part and help, so he was putting us behind even more.” Social loafing also can be explained as individual accountability. Social interdependence theory suggests that lack of individual accountability may reduce feelings of personal responsibility, and accordingly social loafing behavior increases (Johnson and Johnson 2009b).

Table 10 Triggers for task conflict

Group ID #	#1	#2	#3	#4	#5	#6	#7	#8
Task conflict	Content	Content	Content	Format	Format	?	Content	Content + format
Perspectives	√	√	√	√	√	?	√	
Interests		√		√				√

√ indicates presence of corresponding individual differences

Process conflict caused by social loafing resulted in relationship conflict in Group 1, 2, 3, and 4. For example, Jake from Group 4 said, “The tension was caused by the person who doesn’t have normally a high tolerance for people who do not like to work and the person who does not like to work.” Ted also mentioned, “Well every time in the project, he kept playing games a lot. And we told him to stop it, and he stopped, and it just became a disagreement, and we had to threaten him to fire him to get him on task.”

Relationship conflict: differences in personalities and lack of social skills

Relationship conflicts were caused mainly by different personalities (number of occurrences = 4) and lack of appropriate use of social skills (number of occurrences = 5). Seven groups out of eight experienced relationship conflicts, and the causes of the relationship conflicts are summarized in Table 11.

Incompatible personalities, not necessarily different personalities, sometimes triggered relationship conflicts. Jonathan from Group 7 described the cause of his group’s relationship conflict as, “Two personalities are just like crashing against each other. I mean there are similarities, but the differences, maybe we are just too similar. We just can’t like each other.” Lily in Group 2 also indicated incompatible personalities as a cause of their relationship conflict, saying, “My partner and I are both very, like we know what we want, we have our mind set. We both (pause) we are kinda stubborn.”

Lack of social skills transformed a task conflict into a relationship conflict as a group member kept insisting on his own ideas without listening to others and adjusting his beliefs to group norms. This transformation from a task conflict to a relationship conflict was reported by five groups out of six that reported both task and relationship conflicts. Jonathan said:

He was arguing for that, even though everyone was saying there was another way. He’s like, “why can’t we have it in that?” She was trying to change (his mind) and told him why he was being so stubborn that he won’t listen to what she was saying. He would be taking that as an attack on him or his ideas instead of telling you just “No, it’s not”. What really happened is he just thinks everything we say is an attack on him, not his ideas.

A survey respondent described how a task conflict became a relationship conflict. “Well when we had to change something, we would get into fights about it.” Lack of social skills seemed to cause the transformation. As another respondent in the same group said, “Rod thinks he knows stuff, and he calls us all stupid because we don’t agree.”

Conclusion for research question 1

Based on the students’ perceptions, it appears that different factors contributed to each type of conflict. Table 12 summarizes the number of occurrences of factors that triggered each

Table 11 Triggers for relationship conflicts

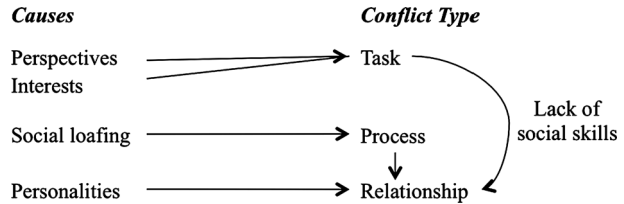
Group ID #	#1	#2	#3	#4	#5	#6	#7	#8
Personalities	√		√			√	√	N/A
Social skills	√	√		√	√		√	N/A

√ indicates presence of corresponding individual differences

Table 12 Triggers for each conflict type

Conflict type	Triggers	Group ID #								Total
		#1	#2	#3	#4	#5	#6	#7	#8	
Task	Perspectives	√	√	√	√	√	?	√		6
	Interests		√		√				√	3
Process	Social loafing	√	√	√	√					4
Relationship	Social skills	√	√		√	√		√		5
	Personality	√		√			√	√		4

Fig. 3 Flow diagram of conflict type and its causes



type of conflict, and Fig. 3 illustrates the relationships between triggers and conflict types. Different perspectives and interests among group members appear to have contributed to task conflicts. Social loafing clearly contributed to process conflicts. Process conflicts caused by social loafing often led to relationship conflicts. Different personalities contributed to relationship conflicts. Lack of appropriate use of social skills triggered relationship conflict and transformed a task conflict into a relationship conflict. Groups experienced more than one type of conflict during their project simultaneously.

RQ 2: How does social skills impact intragroup conflict and collaboration?

Table 13 summarizes intraclass correlations and R square values for each of the two dependent variables: collaboration and conflict. Intraclass correlation indicates proportion of variance in dependent variables explained by between-group differences (Snijders and Bosker 2012). 37.2 % of the variance in collaboration and 17.8 % of the variance in conflict can be attributed to between-group differences. R square values indicate explained proportions of variance for the two levels of the data (Snijders and Bosker 2012). For collaboration, 24.7 % of the variance at the individual level was explained, and 78.3 % at the group level was explained by between-group differences. R square values for conflict were not statistically significant at $\alpha = .05$.

Table 13 Intraclass correlation and R square

	Intraclass correlation	R square	
		Level 1: Individual level	Level 2: Group level
Collaboration	0.372	0.247***	0.783***
Conflict	0.178	0.007	0.956

*** $p < 0.001$

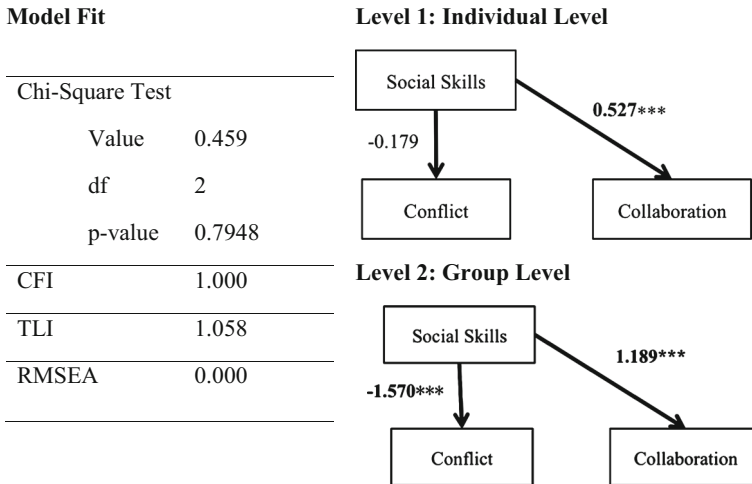


Fig. 4 Multi-level path analysis results. *** $p < 0.001$

Figure 4 presents the results of the multi-level path analysis: all the model fit indices and the path analysis results at the individual level and the group level. Most of the paths were statistically significant at, except the one from conflict to social skills in the individual level with $p = .343$.

At both the individual and group levels, social skills was negatively associated with conflict, which suggested that inappropriate use of social skills increased intragroup conflict. Also, in both levels, social skills were positively associated with collaboration, which suggested that appropriate use of social skills increased the level of collaboration. These results are consistent with the results of the interview data analysis. The interview data revealed that inappropriate use of social skills was the major source of relationship conflict and transformed task conflict into relationship conflict, and that appropriate uses of social skills helped group members collaborate with one another.

Interestingly, the path from social skills to conflict on the individual level was not significant, whereas the path was significant on the group level. These results suggest that individual social skills were not significantly associated with intragroup conflict, whereas the group level of social skills had a significant negative impact on intragroup conflict. That is, it was the social skills of a group as a whole that affected intragroup conflict, not those of individual group members. This suggests that if there were a member with low social skills in a group, the group would not be affected by the person if the other members' social skills were high.

In addition, the regression coefficients on the individual level were smaller than the ones on the group level. That is, the relationships between social skills and the other two factors were more prominent on the group level. This suggests that group members' social skills as a whole was more important than individual members' social skills in intragroup conflict and collaboration.

Conclusion for research question 2

The multi-level path analysis revealed social skills were negatively associated with intragroup conflict but positively associated with collaboration. Furthermore, group

members' social skills as a whole was more important than individual members' social skills in management of intragroup conflict and collaboration. That is, if there were a member with low social skills in a group, the group would not be affected by the person if the other members' social skills were high.

Discussion

Implications

This study sheds new light on intragroup conflict in educational research and the roles of social skills in collaboration and conflict in CPBL. Although socio-cognitive conflict defined by Piaget or task-related conflict is known to function as a catalyst for group discussion, the research findings suggest that different types of intragroup conflicts occur simultaneously most often, possibly deterring the positive impact of the task conflict. Also, empirical evidence suggests that social skills play an important role in resolving conflict and enhancing collaboration as in social interdependence theory (Johnson and Johnson 2009b). Lack of social skills even triggers relationship conflict that are known to be detrimental to collaboration.

An interesting finding of this study is that social skills of a group is more important than social skills of individuals. This finding can be explained by two possibilities. One is that the members with high social skills could have actively resolved conflict among group members and led the other members to collaborate more smoothly. The other possibility is explained by social learning theory (Bandura and McClelland 1977). Members with high social skills may have modeled appropriate use of social skills, and the other members could have learned from their desirable behaviors, thereby enhancing the group's social skills and collaboration level altogether. This finding provides a way to help students collaborate better and resolve conflict more effectively: including a member with high social skills in each group. This can save more time and be more effective than training groups on collaborative skills, as the effect of training on collaborative skills faded when trained groups were disrupted (Prichard et al. 2006a, b). This grouping can be efficiently and easily done by utilizing an integrated technology system. Reigeluth (2014) proposed an integrated technology system that collects personal data relevant to learning and uses the data in planning for instruction. Such a system enables teachers to quickly and easily group students based on their profiles. CSCL literature has explored various ways of group formation in terms of group size and heterogeneity in CSCL environments that take into account other contextual information such as collaboration type and activities (Martín and Paredes 2004; Wessner and Pfister 2001).

Looking at the triggers for the three types of conflict, our research findings suggest other ways of grouping to enhance collaboration. The literature suggests that while task conflict plays a positive role, process and relationship conflicts can negatively influence collaboration (Amason 1996; Jehn 1997; Pelled 1996). Therefore, in order to achieve a high level of collaboration, task conflict should be encouraged, whereas process and relationship conflicts should be carefully regulated.

Task conflict can be promoted in two ways. First, students with different perspectives and interests can be grouped together. This can be done by utilizing an integrated technology system that collects personal data, such as students' interests, and uses the data in planning for instruction (Reigeluth 2014). Such a system enables teachers to quickly and

easily group students based on their interests and perspectives in order to foster task conflicts. However, it should be noted that group members should share common knowledge and interests in the topic to be effectively engage in knowledge sharing and construction (Noroozi et al. 2013). Second, teachers can provide questions to discuss in order to induce relevant task conflict. Asking critical questions is known to invoke higher-order thinking in problem-based learning (Savery and Duffy 1996) and to promote argumentative knowledge construction in computer-supported collaborative learning (Weinberger and Fischer 2006; Dillenbourg and Jermann 2007; Weinberger et al. 2005; Häkkinen et al. 2010).

Process and relationship conflicts can be viewed as side effects of and impediments to collaboration that should be avoided. Process conflict can be reduced (1) by providing procedural scaffolding, as in the projects described in this study, (2) by reducing social loafing behaviors, and (3) by letting students work in the same group over different projects.

Although it is difficult to prescribe sequence of actions and assign roles using scripts as in the CSCL literature, it is still feasible to provide a appropriately structured process in CPBL. In this study, the teachers asked students to complete a group contract, in which they set group rules and norms at the beginning of their group work. Also, the teachers had set several benchmarks along the way, and students needed to turn in specific deliverables at each benchmark.

One suggestion to reduce loafing behaviors is to use a team management technology system such as Zoho Project, RedBooth, or Project Foundry, where members can keep track of the status and progress of each member's work. In the interviews, nine students suggested such a system could be useful. For example, Lily said:

Next time, I think it would be better if the group that I was in and worked with have more group meetings to check in with each other and just see whatever one's doing, like not getting into their personal business or anything, but just to see what they are doing and keeping track of what they are doing and make sure they are not off task, not doing any work.

Lahti et al. (2004) suggest that having a shared group history gives members an understanding of the different stages of group development. Their shared group-work experiences can be used as a reference in their future work. While working with each other in the same group over different projects, the group can find an efficient and effective way to perform their tasks, coordinate their efforts, and deal with social loafing. The group may experience fewer process conflicts, once their group process is habitualized.

Relationship conflict occurred (1) when different personalities clashed, and (2) when there was lack of social skills among group members. While our study found a potential negative relationship between mixed personalities and collaboration through a relationship conflict, some studies suggest a positive impact of mixed personalities on collaboration (Sfetsos et al. 2006). Therefore, this finding should be further investigated before putting it into practice.

In contrast, the appropriate use of social skills has been consistently reported to generate a positive impact on collaboration (Archer-Kath et al. 1994; Putnam et al. 1989; Johnson and Johnson 2009b). Also, the appropriate use of social skills prevented task conflict from being transformed into relationship conflict. The results from the multi-level SEM suggest that increasing group-level social skills can reduce relationship conflict. We suggest three ways to increase group-level social skills. First, as suggested earlier, teachers can group a member having low social skills with one having high social skills. The member with high

social skills will facilitate collaboration by preventing task conflicts from transforming to relationship conflicts and will act as an example of a good collaborator. Second, teachers can conduct a workshop on social skills at the beginning of projects, as the literature suggests. Third, teachers can provide individual feedback on members' social skills during and after the projects.

Limitations

We recognize a couple of limitations of this study. First, this study was conducted in high school classrooms in a school in the Midwest of the United States. The findings could be specific to the context of the study. Second, we utilized self-reported data. Dealing with sensitive information such as conflicts, there could be distortion of data. Jehn (1997) utilized interviews and observations in order to identify conflict types. Therefore, observation or other sources of data would have helped to triangulate the self-reported data. Third, our survey instruments on conflicts may not be enough to examine the relationships between each type of conflict and other variables. To do so, the three types of conflict should be measured separately and, more than one item per construct is needed (Thorndike and Thorndike-Christ 2010). For example, Pelled et al. (1999) used four instruments for each type of conflict. Therefore, we recommend using at least three to four instruments for each type of conflict if one attempts to use one of the structural equation modeling approaches.

Future research directions

We suggest three areas for future research. First, individual difference factors that trigger each type of conflict should be investigated in various contexts. The results of this study, especially the ones based on the interview data, could be confined to the specific situation. Second, methods to induce task conflicts and reduce process and relationship conflicts should be empirically tested and refined. This study suggested various ways to do so, but their effects and specific ways to successfully implement the methods should be further investigated. Third, relationships should be examined among conflicts, collaboration and other factors that social interdependence theory suggests. This study only examined one of the five variables that social interdependence theory suggests impact collaboration (Johnson and Johnson 2009b). The relationships among conflicts, collaboration, and the other four variables (positive interdependence, individual accountability, promotive interaction, and group processing) are worth examination.

Appendix: Survey instruments

Intragroup conflict

How often have the following kinds of disagreements occurred in your team?

	Never	Rarely	Occasionally	Sometimes	Frequently	Usually	Always
Task-related							
Process-related							
Relationship-related							

Social skills

Including yourself, please rate each of your group members with whom you worked on the group project at the following skills. Please be consistent with the order of group members throughout the questions. This survey results will be handled under complete confidentiality. If you had less group members than the provided rows, please skip the rest of the rows.

SC1 Communicating one's idea

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

SC2 Listening to others

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

SC3 Open-mindedness

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

SC4 Empathizing with other group members

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

SC5 Resolving conflicts among group members

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

SC6 Appreciating others' beliefs and personalities

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

SC7 Adjusting one's behaviors to the group's norms and rules

	Extremely poor	Very poor	Poor	Fair	Good	Very good	Extremely good
Yourself							
Member 1							
Member 2							
Member 3							
Member 4							

Collaboration

Given the following statements, please choose the response that best represents your experience.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
I have often engaged in discussion with one or more group members about the project							
Discussion in my group stimulates my thinking							
Everyone's ideas and opinions have been considered by our group							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
Everyone's ideas and opinions have been incorporated into our final deliverables when appropriate.							
My group has engaged in discussion when we have to make a decision							
My group has developed ideas together as a team							
My group has continued discussion until we reached consensus group when we had to make a decision							

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