Enablers and Barriers of Communication in Virtual Engineering Teams: The Role of Teamwork Skills and Emergent Conflict

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Abstract

Communication is a critical process that facilitates team members' coordination, expertise exchange, decision-making, and, consequently, team effectiveness. A focus on effective communication is critical in virtual teams due to their lack of face-to-face interactions and social presence. Communication becomes challenging in remote settings, and specific skills emerge as more essential to success. It is known that effective teams rely on planning, execution, and interpersonal skills to be successful. Still, the specific impact of these skills on virtual team effectiveness is not well understood. Additionally, conflict can emerge as a significant barrier to collaboration for remote teams that can hinder their communication. This paper examines the role of teamwork skills and emergent conflict as predictors of the frequency of communication in virtual engineering project teams. Previously validated measures were used to assess teamwork skills and emergent conflict in a sample of virtual teams. The sample included 101 graduate engineering students working in 32 fully virtual project teams of size 3-4 to complete a semester project on systems analysis and design. Results indicate that skills associated with mission analysis and strategy formulation were the strongest predictors of the frequency of communication, while relationship conflict was associated with low levels of communication. These findings are relevant to organizations that rely on virtual team-based structures by identifying critical levers and barriers to team communication. These findings can be used to identify targets for virtual team training, including a focus on strategic planning and mission analysis, as well as conflict management strategies to prevent and resolve relationship conflict in virtual settings.

Keywords

Virtual teams, communication, teamwork, emergent conflict

1. Introduction

Virtual teams have become a primary form of teamwork in many organizations across industries, fueled by the COVID-driven transition to remote work in 2020 [1, 2]. Virtual team-based structures offer several advantages compared to co-located teams, such as allowing flexible work schedules that facilitate quick response to dynamic business environments and easier access to a global pool of skilled and knowledgeable workforce [3, 4]. Despite these advantages, research shows that virtual teams face several challenges in developing effective communication [1, 5-7]. Communication is a critical process that enables effective collaboration [8, 9], and it has been identified as one of the strongest predictors of virtual team performance [5, 10]. As the adoption of virtual teams continues to rise [2], it is important to advance theory and research on the underpinnings of effective communication in virtual settings.

A team's ability to communicate effectively is critical to overcome the lack of face-to-face interactions and social presence when working remotely [3]. Extensive research has been devoted to examine the factors that affect the communication process in virtual teams [4, 5]. Prior studies suggest that the degree of virtuality [11], language and cultural diversity [5, 12], effective use of technology to communicate [5, 13], and the quality of leadership [12] are important factors affecting virtual teams' communication. Although the literature on virtual teams is continuously growing, questions remain regarding the enablers and barriers of virtual teamwork [5]. The role that specific teamwork skills and emergent conflict play in the collaboration process is not well understood. Such comprehension can provide valuable insights into the critical competencies required to thrive in a virtual environment.

The present study examines the role of teamwork skills and emergent conflict as predictors of communication in virtual engineering project teams. The research question is addressed using a quantitative method. The remaining sections discuss the related work and research hypotheses, the methods adopted in this study, and the results and conclusions.

2. Related work and research hypotheses

Virtual teams are "work arrangements where team members are geographically dispersed, have limited face-to-face contact, and work interdependently through the use of electronic communication media to achieve common goals" [1, p.1]. Virtual teams rely primarily on technology to interact, so they often face more communication challenges than face-to-face teams. This study hypothesizes that team members' teamwork skills and emergent conflict are significant drivers of the frequency of communication in virtual teams. The proposed relationships are examined through the lens of the team effectiveness literature that considers teams as dynamic and complex systems. Under this view, team processes (i.e., communication) are influenced by individual characteristics of team members (i.e., individuals' teamwork skills) as well as affective, motivational, and cognitive factors (i.e., emergent conflict) [14, 15]. The study hypotheses are described next.

Teamwork skills represent a set of behaviors that allow individuals to collaborate effectively in teams [16]. Effective collaboration relies on three types of processes, namely transition, action, and interpersonal [16]. Teams benefit from having members with skills that facilitate planning and execution processes and who can interact with others effectively. In virtual settings, where communication is further challenged by the lack of in-person interactions, teamwork skills that focus on goal alignment and coordination emerge as critical to success. Research on virtual team environments suggests that competencies such as goal setting, coordination, and conflict management are key to address the communication challenges of geographically distributed teams [11, 13]. Given this background, it is hypothesized that members' teamwork skills are positive predictors of the frequency of communication in virtual teams.

> *H1. Planning and goal setting (a), execution (b), and interpersonal skills (c) are positively related to the frequency of communication in virtual engineering teams.*

Conflict can be defined as disagreements between team members' perceptions of values, ideas, and preferences [17]. Research on the influence of conflict on team effectiveness is abundant in the literature [14]. The accumulated knowledge suggests that conflict is omnipresent in teams [12], and it is more prevalent in virtual teams due to their physical distance and technological mediation [12, 18]. Nevertheless, many scholars argue that not all conflict is dysfunctional, and they call to differentiate between two primary forms of emergent conflict: task and relationship conflict. Task conflict captures the presence of divergent ideas and viewpoints related to the task's content and outcomes. Relationship conflict captures interpersonal or emotional tensions among group members [17]. While much is known about how team outcomes are affected by task and relationship conflict, less is known about their role in shaping virtual teams' communication. In this study, we hypothesize that emergent task conflict enhances communication because it reflects the presence of alternative perspectives and diverse ideas in a team. Teams where members feel comfortable expressing divergent viewpoints about the task will be more likely to rely on communication processes than teams that do not express different perspectives.

> *H2a. As the level of task conflict increases, so does the frequency of communication in virtual engineering teams.*

On the other hand, emergent relationship conflict can hinder communication in remote teams as it may impair members' interactions and ability to process task-relevant information. As relationship conflict emerges, team members can become less comfortable communicating with others and less receptive to others' ideas about the task [19]. Due to relationship conflict, members are most likely to limit their communication with others.

> *H2b. As the level of relationship conflict increases, the frequency of communication diminishes in virtual engineering teams.*

3. Methods
3.1. Sample and data collection

This study aimed to examine the role of teamwork skills and emergent conflict as predictors of the frequency of communication in the context of virtual teams. The sample included 101 graduate engineering students working in 32 fully virtual teams of size 3-4 to complete a semester project on systems analysis and design at a University in the Mid-Atlantic region. Regarding gender, 72% were males, and 28% were females. Previously validated instruments

were used to measure participants' teamwork skills, emergent conflict, and communication over four consecutive semesters between Fall 2020 and Spring 2022.

3.2. Variables

The scales used to measure the variables for this study use peer assessment, so every member was assessed by their teammates on their teamwork skills, conflict, and communication. Each measure is an aggregate of the values given to individuals by their teammates. The peer-assessment approach is used to reduce the potential bias from self-assessment metrics. The scales are described as follows.

- Teamwork skills. A 24-item questionnaire developed by Varela and Mead [16] was used to collect peer-assessment data on teamwork skills. The items used a seven-point Likert-type scale (1=strongly disagree, 7=strongly agree) to evaluate the skills required to execute transition, action, and interpersonal processes in teams. Items related to transition processes focus on mission analysis, and goal setting and strategy formulation (6 items, $\alpha=0.905$). An example items is "In teams, this person assists in articulating the team tasks and in planning task achievement". Items related to action processes measure monitoring progress, backup behaviors, and coordination (9 items, $\alpha = 0.931$). An example item is "In teams, this person gets involved in coordinating team members' contributions". Items assessing interpersonal skills focus on conflict management, motivation and confidence building, and affect management (9 items, $\alpha = 0.789$). An example item is "In teams, this person encourages team members to do their best and boost their confidence level."
- Conflict. Task and relationship conflict was based on a measure developed by Behfar and colleagues [17] using six items on a seven-point scale (1=none/not at all, 7=always/totally), three for relationship conflict ($\alpha = 0.715$), and three for task conflict ($\alpha = 0.755$). The items were adapted to a peer-rating format so that participants assessed their perceived levels of relationship and task conflict with each of their teammates. An example item of relationship conflict is "How much are personality conflicts evident between you and [X]?". An example item of task conflict is "How often do [X] and you engage in debate about different opinions or ideas?". Where X is the name of the teammate being evaluated.
- Communication. One item on a seven-point scale (1=not at all, 7=very much) [20] and one item on a seven-point scale (1=strongly disagree, 7=strongly agree) [21] were used to characterize the frequency of communication between team members. Given that the items combined two instruments and used different scales, a standardized value estimated from the average of responses was used for the statistical analysis. An example item is "Did you communicate with [X] about project-related matters?".

3.3. Analysis

The collected peer-assessment data was structured in adjacency matrices to estimate the study variables. The adjacency matrices represent person-by-person tables where the first row and first column list the team members, and cells' entries indicate the respective assessments a person received from their teammates in each item. Then, matrices from items measuring the same variable were combined to form a variable adjacency matrix (i.e., task conflict matrix). The arithmetic average obtained from each column of the variable matrix was used to represent individual-level measures of teamwork skills, conflict (task and relationship), and frequency of communication. A preliminary data exploration led to exclude four data points due to missing values in one or more variables, which reduced the final sample to 97 participants. The study hypotheses were tested using stepwise regression analysis. In this analysis, the independent variables are entered into the model in a forward direction until the best predictors of the response variable are found [22]. The response variable in the regression model was the frequency of communication and the independent variables included teamwork skills, task conflict, and relationship conflict. The selection of the best predictors in the model from the stepwise process was based on the adjusted r-squared and the AIC (Akaike Information Criterion) index.

4. Results

Descriptive statistics of the variables are presented in Table 1. Results of the stepwise regression analysis indicated that planning and goal-setting skills are significant and positive predictors of the frequency of communication, providing support for *H1a*. Results also suggest that relationship conflict was a negative and significant predictor of the frequency of communication, supporting *H2b*. The final model from the stepwise regression indicated that planning skills and relationship conflict are the only significant predictors of the frequency of communication (Table 2). Thus, hypotheses *H1b*, *H1c*, and *H2a* were not supported. The model with two predictors explained 22.1% of the variance in the frequency of communication in virtual engineering project teams.

Table 1: Descriptive statistics of the study variables

Variable	Mean	SD
Planning and goal-setting skills	6.09	0.786
Execution skills	5.96	0.810
Interpersonal skills	6.00	0.651
Task conflict	3.62	1.290
Relationship conflict	1.23	0.365
Communication	0.005	0.897

Table 2: Results of the stepwise regression of communication in virtual engineering project teams

Variable	Estimate	Std. Error	t-value	p-value
(Intercept)	-1.169	0.738	-1.583	0.116
Planning and goal-setting skills	0.354	0.104	3.397	<0.001
Relationship conflict	-0.799	0.225	-3.557	<0.001

Adj. R-squared: 0.221, F (2,94) = 14.6, p-value < 0.001

5. Conclusions

In this study, our goal was to examine the role of teamwork skills and emergent conflict in predicting virtual teams' frequency of communication. It was expected that planning and goal setting, execution, and interpersonal skills, and task-related conflict act as enablers of communication in virtual environments. We also expected that relationship conflict would emerge as a barrier to communication by hindering team members' interactions. Results of the stepwise regression analysis indicated that only planning and goal-setting skills and relationship conflict were significant predictors of the frequency of communication. On the other hand, execution and interpersonal skills were not substantial drivers of communication frequency, suggesting that the early stages of collaboration are the most influential on the communication process. Planning skills displayed a positive coefficient in the model, indicating that members who are competent in mission analysis and strategy formulation are key to facilitating the intrateam communication process in virtual environments. This result extends our knowledge of the relevance of goal-setting and role clarification skills in the context of virtual teams [11]. The skills associated with developing a shared vision and accountability, and establishing clear roles and strategies are valuable assets that can enhance communication. Regarding the role of conflict, relationship conflict was associated with decreased levels of communication, suggesting that as disagreements and tension with others in the team increases, members are more likely to isolate themselves from others in the team. The findings presented in this paper might be relevant to organizations that rely on virtual team-based structures by identifying critical levers and barriers to team communication. These findings can be used to identify targets for virtual team training, including a focus on strategic planning and mission analysis, as well as conflict management strategies to prevent and resolve relationship conflict in virtual settings. This study highlights the importance of focusing on the preparation processes prior to project execution, including setting up a shared vision, clarifying roles and responsibilities, and developing a plan for the team. A limitation of this study is that the research design limits the inferences about causality and the generalizability of our results to other types of teams. However, it provides new insight into the communications process in virtual teams by identifying essential drivers such as individual skills and processes, and key barriers to communication such as relationship conflict.

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