4-2013

Virtual Team Effectiveness: Investigating the Moderating Role of Experience with Computer-Mediated Communication on the Impact of Team Cohesion and Openness

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Abstract

The work of virtual teams is increasingly important to today's organizations, work that is accomplished predominantly via computer-mediated communication. The authors investigate the moderating role of experience with instant messaging on the team interpersonal processes (cohesion and openness) to team effectiveness relationship in virtual teams. Data were obtained from 365 virtual team members using survey methodology and analyzed using hierarchical moderated regression and multilevel analyses. They found that team cohesion has a main effect on team effectiveness. Team openness has a main effect and is moderated by experience with instant messaging, i.e., strengthens the relationship. Understanding the role of team interpersonal processes and the role of the communication media will allow managers to more effectively build virtual teams and provide effective training and support. Using the theoretical lens of channel expansion theory the authors expand theoretical, empirical and practical knowledge of this area.

Keywords

Disciplines

Business Analytics | Communication Technology and New Media | Digital Communications and Networking | Management Information Systems | Technology and Innovation

Comments

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ABSTRACT

The work of virtual teams is increasingly important to today's organizations, work that is accomplished predominantly via computer-mediated communication. The authors investigate the moderating role of experience with instant messaging on the team interpersonal processes (cohesion and openness) to team effectiveness relationship in virtual teams. Data were obtained from 365 virtual team members using survey methodology and analyzed using hierarchical moderated regression and multilevel analyses. They found that team cohesion has a main effect on team effectiveness. Team openness has a main effect and is moderated by experience with instant messaging, i.e., strengthens the relationship. Understanding the role of team interpersonal processes and the role of the communication media will allow managers to more effectively build virtual teams and provide effective training and support. Using the theoretical lens of channel expansion theory the authors expand theoretical, empirical and practical knowledge of this area.

Keywords: *Channel Expansion Theory, Computer-Mediated Communication, Team Effectiveness, Virtual Teams, Team Processes*

INTRODUCTION

The importance of effective teams to modern organizational performance is a topic of long-standing interest (Guzzo & Dickson, 1996). Organizations are increasingly using virtual teams to accomplish a variety of tasks in the organization (Gibson & Cohen, 2003) as more and more of that work is shifting to integrated tools known as collaboration technologies (Spreitzer, 2003) using computer-mediated communication (CMC) such as e-mail and

instant messaging (IM). As a result, the nature of team interaction and the relationship between teamwork and outcomes is evolving (Kirkman, Rosen, Tesluk, & Gibson, 2004). However, little is known about the effect of experience with CMC in enabling or hindering the impact of team processes on performance outcomes. The performance outcome we examined is team effectiveness, defined here as perceptions that the team worked effectively together in accomplishing a collaborative task. The goal of this research is to examine the moderating role of experience with CMC (i.e., instant messaging) on the relationship between team interpersonal processes (i.e., cohesion, openness) and team effectiveness in virtual teams.

Our research examines the development of team interpersonal processes, or processes that involve relationships among team members (Martins, Gilson, & Maynard, 2004), and the subsequent impact on outcomes in virtual teams. The relationship between team processes and outcomes can be described by the shared mental models theory that suggests the degree to which team members share a common knowledge framework will allow team members to adapt their behavior to better complete a task (Cannon-Bowers & Salas, 2001). While this interpersonal-outcome relationship has received a great deal of attention in the literature, most empirical studies deal with face-to-face relationships not virtual teams (Martins et al., 2004). Furthermore, by their nature virtual teams may struggle more than face-to-face teams with forming cohesive bonds and sharing information openly (Alge, Wiethoff, & Klein, 2003; Warkentin, Sayeed, & Hightower, 1997); however, the possible impact of user experiences on teamwork has not been examined. Thus, we are interested to see if virtual teams can utilize these interpersonal processes (i.e., cohesion and openness) in such a way that they contribute to the effectiveness of the team and whether user experience can moderate those relationships.

Thus, one contribution of the current study is that we answer the call for research on the team interpersonal processes that impact outcomes in virtual teams (Martins et al., 2004), as well as the generalizability of face-to-face communication constructs on the performance of such teams (Fjermestad, 2004; Kim, 2006). Some research has investigated cohesion in virtual teams (e.g., Cramton, 2001; Gonzalez, Burke, Santuzzi, & Bradley, 2003; Knight, Pearson, & Hunsinger, 2008; Straus, 1997; Wakefield, Leidner, & Garrison, 2008; Yoo & Alavi, 2001). For example, cohesion influences social presence and task participation in established groups (Yoo & Alavi, 2001), but the cohesion-performance link is weaker for teams using leaner communication media (Knight et al., 2008). While cohesiveness may improve team effectiveness by building collective team knowledge, team effectiveness also hinges on the extent to which team members are open and willing to share knowledge (Driskell, Radtke, & Salas, 2003). To our knowledge, team member openness, or the degree to which teammates openly share and receive information, has seldom been examined in a virtual context. We propose that both cohesion and openness will be related to team effectiveness for virtual teams.

A second purpose of this study was to investigate the possible impact of "channel expansion" on the participants' ability to use interpersonal team processes to develop team knowledge and subsequently accomplish teamwork. Channel expansion theory suggests that experience of several forms contributes to an individual's ability to communicate richly using a given medium (Carlson & Zmud, 1999). We are focusing exclusively on experience with the medium and its moderating role in the interpersonal processes-outcome relationship of virtual teams. In addition to the role of communication in virtual teams, technology experience has been specifically identified as a key construct to examine in collaboration technologies (Jones & Kochtanek, 2004). More specifically, the CMC technology employed in this study was designed for this investigation and uses computer-based instant messaging ("IM" or "chat") as well as a task interface that includes a voting tool. Several different terms

are used in the literature to describe a computer-based information system created and used to support teamwork; the characteristics of our technology fit well with the term collaboration technology (Mitchell & Zigurs, 2009). Our technology employs IM as the CMC medium; as such, the term "medium" is used here to describe the IM component of our collaboration technology. IM is an increasingly popular way to communicate in the modern workplace, and more workers today are gaining experience and aptitude with IM (Cao & Everard, 2008; Gordon, Tarafdar, Cook, Maksimoski, & Rogowitz, 2008). Applying channel expansion theory, we believe that experience with IM will enhance the ability of the interpersonal team processes to contribute to effectiveness. Specifically, we believe that greater experience enables the team to better leverage interpersonal processes in the effectiveness of their work. Thus, we are integrating two theoretical frameworks to more accurately represent the occurrence of virtual teams in today's organization.

In the following sections we will discuss the theoretical foundations in detail, define the constructs of interest, develop and test hypotheses related to the relationships described, and finally discuss how these findings might be interpreted and integrated into our understanding of the development of virtual teams.

THEORETICAL FOUNDATIONS

While there is a good deal of research on the different team characteristics associated with virtual work, there is not yet consensus on the definition of virtual teams (Curseu, Schalk, & Wessel, 2008). However, it is commonly agreed that virtual teams are made up of two or more persons in different locations who collaborate interactively via CMC to achieve a common goal (Martins et al., 2004). Because CMC facilitates the transfer and use of knowledge across time and space there has been a large expansion in the use of virtual teams in today's organization (Curseu et al., 2008; Gibson & Cohen, 2003). Research on the interpersonal processes of virtual teams has examined conflict

(e.g., Mortensen & Hinds, 2001), communication formality (e.g., Saphiere, 1996; Walther, 1994), trust (e.g., McAllister, 1995; Walther, 1994), and to some extent cohesion (e.g., Yoo & Alavi, 2001), but little research has yet addressed team openness, although both cohesion and openness have demonstrated value in face-to-face teams (e.g., Barrick, Stewart, Neubert, & Mount, 1998; Breen, Fetzer, Howard, & Prezjosi, 2005). Thus, we examine the moderating effect of experience with CMC on the ability of two team interpersonal processes, cohesion and openness, to contribute to effectiveness in a virtual team (Figure 1).

Shared Mental Models

Research suggests that team members create shared mental models when engaged in action toward a common goal (Cannon-Bowers, Salas, & Converse, 1993). Shared mental models are "knowledge structures held by members of a team that enable them to form accurate explanation and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members" (Cannon-Bowers & Salas, 2001, p. 228). Shared mental models have been found as one of the main factors impacting team effectiveness (Cannon & Edmondson, 2001). This theory suggests that shared mental models influence team effectiveness by decreasing communication demands during task performance allowing more energy to be devoted to the task by team members (Langan-Fox, Anglim & Wilson, 2004). We captured the shared mental models by examining the interpersonal processes of team cohesion and team openness.

Cohesion

Team cohesion describes the strength of the bond that pulls team members together (Beal, Cohen, Burke, & McLendon, 2003; Tekleab, Quigley, & Tesluk, 2009). Team cohesiveness occurs when members are attracted to the team and its task (Kozlowski & Bell, 2003). Cohesive teams are generally united in working toward team goals, and team members tend to experi-

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Figure 1. Moderating role of IM Experience on the team effectiveness process
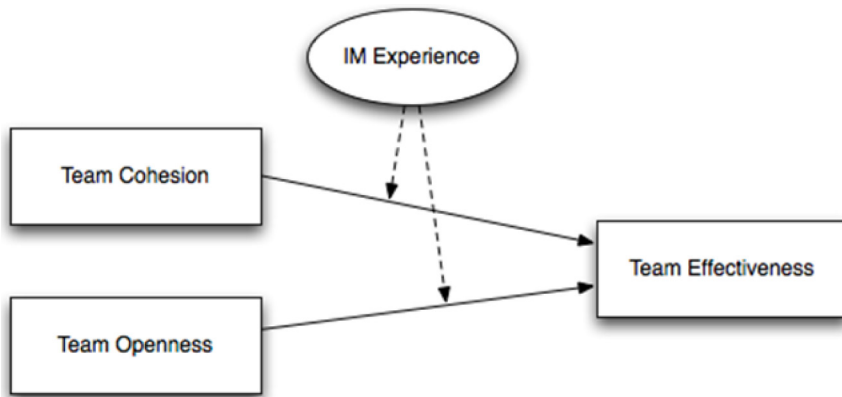
ence friendships and mutual trust. Research demonstrates that team cohesion relates positively to decision quality (Knight et al., 2008; Mennecke & Valacich, 1998) and general team effectiveness (Barrick et al., 1998), partly by decreasing social loafing (i.e., reductions in individual contributions to the team output; Karau & Hart, 1998). Further, cohesive teams are more likely to develop shared mental models as they communicate and share information thus reducing communication demands. Indeed, the role of cohesion in the virtual team seems key, having been found to be associated with higher satisfaction (Chidambaram, 1996) and more participation and consensus (Yoo & Alavi, 2001).

We believe that cohesive relationships can exist in and impact the work of virtual teams using CMC. Although previous research suggests that dispersed teams face more challenges to developing cohesion (Cramton, 2001), when a team achieves a high level of cohesion, each teammate is fully engaged in the task and thus more likely to build shared team knowledge. Therefore, cohesive team members will likely participate and contribute to the goal of the team, ultimately impacting team effectiveness on a problem-solving task positively. Therefore, as shown in Figure 2 we predict

H1: Cohesion will be positively related to team effectiveness.

Openness

Bulach (2003) defines openness as an interpersonal state that exists between individuals in a team when (1) they share "facts, ideas, values, beliefs, feelings and the way they do things" (Bulach, 2003, p. 43) with each other, and (2) the recipient(s) are willing to receive the information. Openness is an important factor for enhancing understanding and cooperative behavior in teams (Tjosvold, 1998). Openness helps promote a positive exchange of ideas and information that advances understanding and promotes cooperation (Barker, Tjosvold, & Andrews, 1988; Bizman & Yinon, 2004; Pascoe & More, 2008). Openness is positively related to decision-making effectiveness (Breen et al., 2005) and is an important factor in the development of trust in teams (Robin, 2007). Openness captures the concept of being open to learn from others and being willing to make an effort to see other's viewpoints (Hobman, Bordia, & Gallois, 2003). Thus, consistent with shared mental models theory, knowledge sharing involves the willingness to discuss with teammates issues, thoughts, and ideas and cooperate in the event that conflict arises.

Openness is seen to develop in virtual teams using CMC as individuals are more likely to ask intimate questions of their teammates (Tidwell & Walther, 2002) and exhibit more tension releasing acts (such as joking) than face-to-face

Figure 2. Study hypotheses
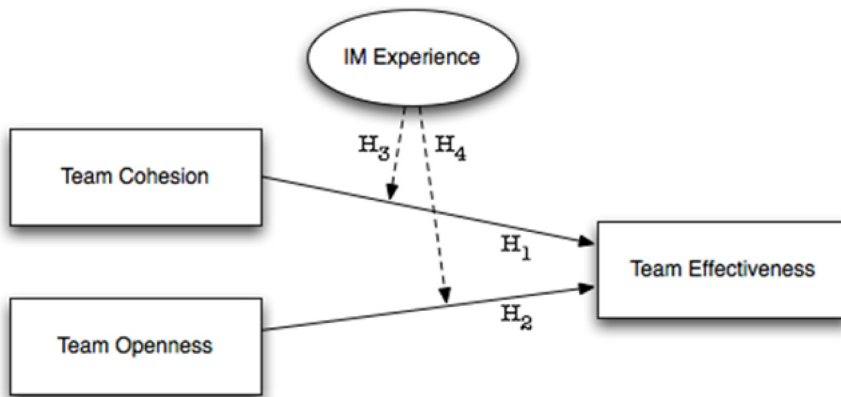
teams (Hiltz, Johnson, & Turoff, 1986). We believe that openness facilitates higher levels of integration within teams and more shared team knowledge consistent with shared mental models theory. Therefore, openness developed in the interpersonal processes of virtual teams will contribute positively toward their ability to accomplish their task effectively as a team. Therefore, as shown in Figure 2 we predict

H2: Openness will be positively related to team effectiveness.

Channel Expansion Theory

The ability of teams to communicate "richly" is a key facilitator of effective collaboration, even in virtual teams (e.g., Alge et al., 2003). Rich communication includes communication with immediate feedback, multiple cues and channels, personalization, and variety of language (Daft & Lengel, 1986). Channel expansion theory (Carlson & Zmud, 1999) is often applied to computer-mediated technologies to describe how participants might be able (or unable) to communicate richly (e.g., Dickey, Burnett, Chudoba, and Kazmer, 2007; Davis, Murphy, Owens, Khazanchi, & Zigurs, 2009). Channel expansion theory identifies four key knowledge-based experiences as driving the ability of an individual to communicate richly on a given medium: experience with the medium, expe-

rience with communication co-participants, experience with the communication topic, and experience with the communication context. This theory has generally found strong empirical support across the spectrum of communication media (e.g., Carlson & George, 2004; Carlson & Zmud, 1999; D'Urso & Rains, 2008; King & Xia, 1997; Timmerman, & Madhavapeddi, 2008), indicating that as communicators gain relevant experiences they discover the ability to use even so-called "lean" media such as CMC to handle rich, equivocality-reducing, socio-emotional communication. Therefore, we are applying channel expansion theory to the foundation of shared mental models as we combine these literatures to more explicitly understand this complex relationship.

According to channel expansion theory, as participants gain experience with a communication medium, they learn to communicate more richly by taking advantage of medium-specific affordances such as emoticons, acronyms, abbreviations and other conventions that allow them to encode and decode messages more richly (Carlson & Zmud, 1999). In other words, channel expansion theory suggests that the process outlined by shared mental models may be enhanced under certain conditions. Thus, participants are better able to express emotional and relational messages using CMC, even without the verbal and body language cues that facilitate face-to-face interactions.

In addition, smaller teams (such as our dyads and triads) are likely to create a richer, more socially-present communication environment thereby supporting the ability of openness and cohesion to positively influence team outcomes (e.g., Lowery, Roberts, Romano, Cheney, & Hightower, 2006).

Experience with Computer-Mediated Communication

Although there are several possible knowledge-building experiences to investigate when using collaboration technology, we chose to focus on the specific experience the subject had using the communication medium (i.e., IM). Although IM is not the only communication medium supported in collaboration technology, it is commonly used to support virtual teams, and experience with the technology is considered a key factor in the effective use of collaborative systems (Jones & Kochtanek, 2004). In a recent review of such technologies, IM is included in 5 out of 7 technology categories (including, for example, Microsoft Netmeeting; Mitchell & Zigurs, 2009). While we would expect to see an increased use of video conferencing as that technology and supporting infrastructure improves, IM still provides the advantages of simultaneous (non-blocking) input (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1997) and an easily accessed and consulted communication history (e.g., Dennis, Fuller, & Valacich, 2008; Dennis & Valacich, 1999).

Past research suggests that virtual teams take more time to complete tasks than teams working face-to-face, partly because typing is more time-intensive than talking (Bordia, 1997). However, these differences occur because teams often require time to become accustomed to the medium (Hollingshead, McGrath, & O'Connor, 1993). If one or more team members are experienced in using the medium, open communication among team members will be more efficient, which may impact the team's overall effectiveness. Moreover, experience with IM may allow teams to more effectively leverage their cohesive bonds to communicate information needed to reach a consensus on the

problem-solving task. Therefore we believe that consistent with both channel expansion theory and shared mental models, experience with the communication technology is a key enabler that enhances the impact of cohesion and openness on effectiveness. Therefore, as shown in Figure 2 we predict

H3: Experience with IM will moderate the impact of cohesion on effectiveness such that the impact of cohesion will be greater with more experience with IM.
H4: Experience with IM will moderate the impact of openness on effectiveness such that the impact of openness will be greater with more experience with IM.

METHOD

Sample

The sample consists of 365 undergraduate (85%) and graduate students (15%) at a southern U.S. university who completed a short team decision-making activity and responded to a survey concerning the computer-mediated technology. The teams were solicited using extra credit from multiple sections of the business information systems survey course. Although specific extra credit varied by instructor, it was designed in each case to provide adequate motivation to perform well and was typically around 3%. Subjects were invited to come at scheduled times outside of class in groups of two or three, or to come individually to be randomly placed in a dyad or triad. The 152 teams varied in size with 50% of the teams consisting of two respondents and 50% consisting of three respondents. The average age of the respondents was 21 and 54% were male. Forty-three percent of the respondents were currently employed either part- or full-time.

Task

Teams were introduced to a web-based collaboration technology with an interface composed of three components: (1) a scrollable IM window,

(2) a decision-making scenario description, and (3) a voting panel. Team members communicated with each other solely through this computer-mediated interface. Teams were placed in a large computer lab such that no team members were near each other or adjacent to subjects in other teams (in general, there were at most 2 teams carrying out the task at any point in time, so keeping them apart was not difficult). Subjects had to respond to ten consecutive task scenarios in which all members of the team must collaborate to reach an agreed-upon solution to each scenario before being allowed to proceed to the next. The 10 task scenarios were general scenarios designed to represent real world survival situations (e.g., in which direction to throw a flare when your boat is stranded). The tasks had no time limit and, although there were nominally correct answers to each scenario, subjects were not apprised of those solutions and no feedback concerning their solutions was provided. The focus of the activity was developing a consensus answer and convincing team members to select it.

Measures

All of the items on the survey were on a 7-point Likert scale with anchors of strongly disagree (1) to strongly agree (7). The items in the scales were averaged to create an overall mean for each variable. The first two scales (cohesion and openness) were adapted from the Michigan Organizational Assessment Questionnaire (Cammann, Fichman, Jenkins, & Klesh, 1983) and were asked in a pre-test instrument, along with experience with CMC and the demographic and control variables. Subjects were formed into teams, introduced to the experimental task, and completed the pre and post-test instruments at the same time as their teammates, giving subjects the frame of reference needed to respond to the items measuring cohesion and openness. The full set of items for each scale can be found in the Appendix.

- **Cohesion:** The cohesiveness of the team was measured with three items (Cammann

et al., 1983). The Cronbach alpha for the scale was .73.
- **Openness:** Two items were used to capture the openness of the team (Cammann et al., 1983). The Cronbach alpha for the scale was .85
- **Experience with CMC:** We used a 5-item measure to tap experience with CMC (i.e., instant messaging) adapted from the media familiarity scale developed by Carlson and colleagues (e.g., Carlson & George, 2004). The Cronbach alpha for the scale was .88.
- **Effectiveness:** Perceptions of team effectiveness were captured by 4 items developed for this study and asked in a post-test instrument. The Cronbach alpha for this scale was .66.
- **Control Variables:** We controlled for three variables in our study: gender of respondent, age of respondent, and team size.

Analysis

To test our hypotheses, we used hierarchical moderated regression analyses. The control variables were entered in the first step. The centered independent variables of cohesion and openness were entered in the second step and this step tested the main effects predicted in H1 and H2. In the third and final step, the centered moderating variable of experience and the interaction terms formed from the centered variables were entered and used to examine the moderation effects predicted in H3 and H4.

RESULTS

Check for Nonindependence of Data

The participants were clustered in teams of two or three students each. Thus, there is the potential that our data are not independent and need to be analyzed at two levels (the individual level and the team level). To determine the appropriate level of analysis we computed the intraclass correlation coefficient 1 (ICC1, representing the amount of variance that resides

between teams) and the intraclass correlation coefficient 2 (ICC2, representing the stability of the team means) for each study variable. The ICC(1)s for cohesion, openness, experience and effectiveness were .38, .11, .11 and .16, respectively. The ICC(2)s for the same variables were .60, .23, .24 and .32, respectively, all of which are below the generally accepted level of .70 (Harris, Kacmar, & Zivnuska, 2007). These results suggest there was insufficient variance between teams coupled with low stabilities of their means to warrant modeling these variables at the team-level. However, given that ICC(1)s as low as .04 have been shown to bias standard errors if the nesting of individuals in groups is not accounted for (Branum-Martin et al., 2006), we replicated our individual-level analyses using variables at the team-level. Thus, to show consistency of our results across both the individual and team-levels, we conducted hierarchical moderated regression separately on the individual-level variables (N = 365) and those same variables aggregated to the team-level (N = 152).

Discriminant Validity

In order to establish the constructs of interest in the study were unique we estimated a measurement model using LISREL (Joreskog & Sorbom, 1993). We tested a four factor model where each of the four scales loaded on their unique factor that had good fit (χ^2 (68, N = 365) = 193.12, p < .01; RMSEA = .07; CFI = .97). Discriminant validity was assessed by constraining the estimated correlation parameter between two scales to 1.00 and comparing the resulting chi-square statistics to the chi-square obtained for the measurement model (Anderson & Gerbing, 1988). Thus, six chi-square tests were conducted and the result indicated the constrained model was significantly different each time from the measurement model suggesting discriminant validity of the four scales in the model.

   To further examine this issue, we used Fornell and Larcker's (1981) recommendations to test for discriminant validity. According to Fornell and Larcker, discriminant validity is sup-

ported if the average variance explained in the items by the construct is greater than the amount of variance in the construct that is shared with another construct. We first calculated variance extracted estimates for each scale by dividing the sum of the squared factor loadings by the sum of the squared factor loadings plus the sum of the variance due to random measurement error in each loading (see Netemeyer, Johnston, & Burton, 1990). These values were then compared to the squared parameter estimates of the correlations between each latent construct. If the variance extracted estimates exceed the squared correlations, then discriminant validity is indicated. The variance extracted estimates for our four scales exceeded the squared correlations in all but 3 cases: the variance extracted estimates for cohesion (.48) and effectiveness (.36) were not greater than the squared correlations between cohesion and openness (r^2=.52), effectiveness and openness (r^2=.48), and cohesion and effectiveness (r^2=.39). Thus, while the results from this discriminant test were much more rigid and some of the indicators of discrimination were close, the sum of the findings across both tests provide adequate support for the four scales used in our study.

Common Method Variance

Since all variables were collected from the same source, we took several precautions to minimize common method biases by following both the procedural and statistical remedies offered by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). Using LISREL 8.80, we estimated a 1-factor model on just the 14 items. Second, we estimated a full measurement model, which included a factor for each of the four variables measured. Next, we estimated a model that included a fifth latent variable to represent a method factor and allowed all 14 items to load on this uncorrelated factor (Podsakoff et al., 2003). The X^2 difference tests indicated that while the 4-factor measurement model was a better depiction of the data than a 1-factor model, adding a method factor improved the measurement model.

To determine the extent of the influence of common method variance (CMV), the variance explained by the method factor can be calculated. In our case, CMV accounted for only 14% of the total variance, which is less than the 25% observed by Williams, Cote, and Buckley (1989). As such, we believe that the procedural and statistical precautions taken to control CMV in our study were effective and that the results found are substantive.

Hierarchical Moderated Regression Results

The means, standard deviations, and correlations of the study variables are found in Table 1. Table 2 provides the results from our hierarchical moderated regression analysis using individual-level variables. In step 1 none of the control variables were related to our outcome. Step 2 which considered the team variables was significant F=33.01 (p<.01) and cohesion was positively and significantly related to effectiveness providing support for H1. Next, openness was positively and significantly related to effectiveness, thus providing support for H2. In addition, this step explained 31% of the variance in effectiveness.

Step 3 (F=22.61, p<.01) included the moderator and the interaction terms. The cohesion by experience interaction was not significant thus failing to support H3. However, the experience by openness interaction was significant supporting H4. In order to examine these results we graphically illustrated the interactions. To form the figures, we utilized a procedure similar to one recommended by Stone & Hollenbeck (1989) where we plotted two slopes: one at one standard deviation below the mean and one at one standard deviation above the mean. A graph of the interaction between experience and openness can be found in Figure 3. We conducted simple slopes test for the lines graphed in Figure 3 to determine if the slopes differed from zero. Both the line at one standard deviation above the mean (t=9.44, p<.01) and the line one standard deviation below the mean (t=6.91, p<.01) were significantly different from zero. As is evidenced, those with more experience with IM are better able to capitalize on the openness to effectiveness relationship. For exploratory purposes, we also tested a three-way interaction between cohesion, openness, and experience, but the three-way interaction term was non-significant.

Table 3 provides the results from our hierarchical moderated regression analysis using aggregated team-level variables. Similar to the individual-level results, the control variable group size was not significant in step 1. In step 2, team-level cohesion and openness were positively and significantly related to team-level effectiveness (F=23.94, p<.01). Thus, H1 and H2 were supported at the team-level as well.

Table 1. Mean, standard deviation, and correlations variable

	Mean	SD	1	2	3	4	5	6	7
1. Team Size	2.50	.50	–						
2. Age	20.85	2.25	-.02	–					
3. Gender	.46	.49	.03	-.18*	–				
4. Cohesion	5.35	1.16	-.13*	-.03	-.01	.73			
5. Openness	5.87	.99	-.12*	-.08	.09	.47*	.85		
6. Experience	6.16	.86	-.11*	-.21*	.00	.21*	.30*	.88	
7. Effectiveness	5.69	.85	-.04	.02	-.03	.41*	.52*	.35*	.66

Note: N = 365; Internal consistency reliability given along the major diagonal.
*p < .05.

Table 2. Hierarchical moderated regression results for individual-level variables

Variable	Step 1	Step 2	Step 3	R^2	Change R^2
Step 1: Control Variables				.00	.00
Team Size	-.03	.05	.05		
Gender	.02	-.05	-.05		
Age	.02	.06	.06		
Step 2: Main Effects				.32*	.32*
Cohesion		.23*	.68*		
Openness		.43*	.41*		
Step 3: Moderation				.34*	.02†
Experience			.40†		
Experience X Cohesion			-.06		
Experience X Openness			.13*		

Note: Standardized regression coefficients
†p < .10. *p < .05.

In step 3 (F=13.85, p<.01), we again failed to support H3 as the interaction between team-level cohesion and team-level experience was not significant. However, the interaction between team-level openness and team-level experience was significant in support of H4. Figure 4 is a graph of this interaction. A test of simple slopes revealed that both the line at one standard deviation above the mean (*t*=6.09, *p*<.01) and the line one standard deviation below the mean (*t*=2.31, *p*<.05) were significantly different from zero. Similar to the previous graph, those with more experience with IM are better able to capitalize on the openness to effectiveness relationship. Finally, the three-way interaction term between cohesion, openness, and experience was non-significant at the team-level.

Figure 3. Plot of the interaction between openness and experience on effectiveness
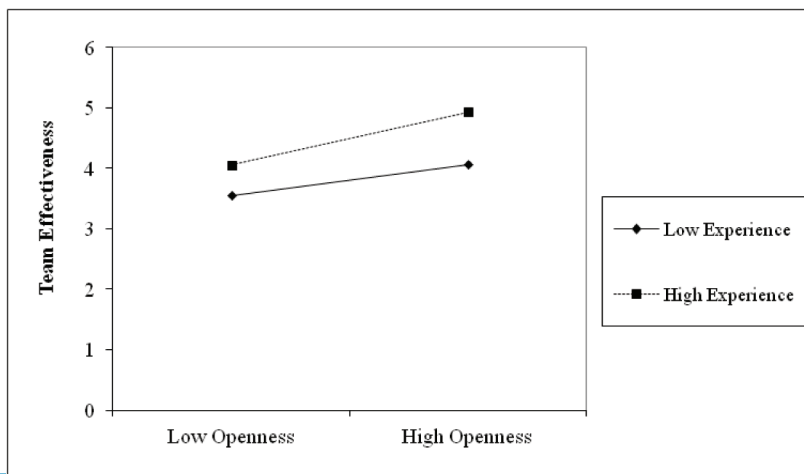
Table 3. Hierarchical moderated regression results for team-level variables

Variable	Step 1	Step 2	Step 3	R^2	Change R^2
Step 1: Control Variable				.00	.00
Team Size	-.05	.05	.05		
Step 2: Main Effects				.31	.31*
Cohesion		.21*	.21*		
Openness		.44*	.46*		
Step 3: Moderation				.34*	.03*
Experience			.02		
Experience X Cohesion			-.11		
Experience X Openness			.21*		

Note: Standardized regression coefficients

*p < .05.

DISCUSSION AND CONCLUSION

The goal of this research was to examine the moderating role of experience with CMC on the relationship between team interpersonal processes (cohesion and openness) and virtual team effectiveness (Figure 1). Our findings suggest that team cohesion plays a positive and significant role in the effectiveness of teams in a virtual setting. In addition, team openness has a positive relationship with virtual team effectiveness. Interestingly, the effects of openness are enhanced by the subject's experience with instant messaging, such that the team member can utilize openness to facilitate higher effectiveness.

The finding of a positive relationship between team cohesiveness and team effectiveness echoes previous research that has found this relationship (Barrick et al., 1998) in face-to-face teams. Supporting this relationship for virtual

Figure 4. Plot of the interaction between team-level openness and team-level experience on team-level effectiveness
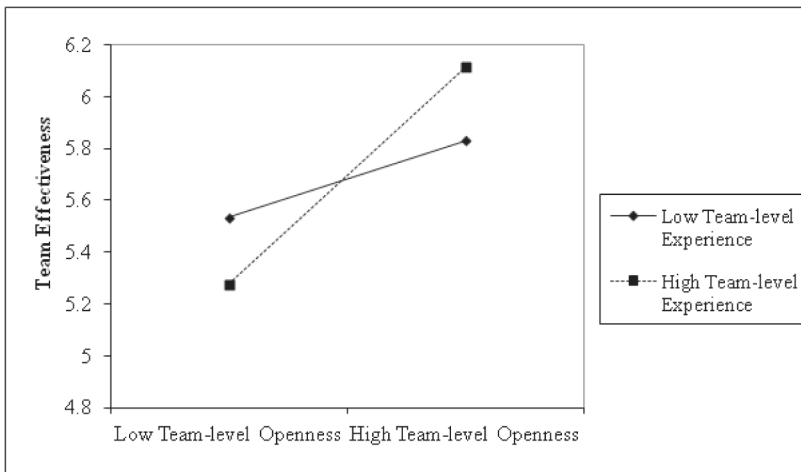
teams confirms its importance in IM settings as well, extending earlier work involving e-mail (Knight et al., 2008). Therefore, in cohesive virtual teams, team members were able to share team knowledge via CMC in a manner that allowed them to be more effective in the given task. Our findings confirm that team interpersonal processes are relevant in the virtual setting (Martins et al., 2004). However, the moderation of experience with the medium was not found for cohesion. It is possible that we did not have teams that experienced enough cohesion to make a difference in how they were able to use the medium. Further, it is possible that use of IM did not make students feel any more or less meaningfully connected to the other team members while, at the same time, experience did enhance openness for this student sample (who are likely to be extremely forthcoming to what they will say in an IM setting).

The current study did support past research that positively links openness with positive outcomes (Breen et al., 2005; Robin, 2007) and extends it to the outcome of effectiveness in a virtual setting. Thus, team effectiveness was higher if team members were willing to communicate in a more open manner. Further, the moderation of experience with the medium was significant such that the greater the experience with IM the more team members were able to exploit their openness via CMC to contribute to effectiveness. Thus, experience with IM allowed teammates to more efficiently share and receive knowledge via the CMC medium. Therefore, being able to use the medium in a way that encouraged communication was a strength in this virtual setting.

There are also practical implications of this research. This research supports the importance of developing team interpersonal processes in teams even when they are virtual. The importance of feeling cohesive and sharing openly are both relevant in the team process so the degree to which they can be encouraged in an organization setting will be beneficial. In addition either finding team members who are experienced in the CMC used or providing training on CMC would be beneficial to organizations to enhance the team outcomes.

Strengths, Limitations, and Future Research

There are several strengths of this study. First, we designed a study that allowed us to observe virtual teams with team members who possessed a good deal of experience using the study medium (IM). Despite this generally high level of medium experience, we were able to capture and explain differences in team effectiveness. Second, we were also able to extend the knowledge of interpersonal processes in virtual teams. While there is research that examines process in virtual teams (Martins et al., 2004), we extended this line of work to include the processes of openness and cohesion in relationship to virtual team effectiveness. Third, we combined two fields of knowledge to better understand and reflect what is actually occurring in organizations today.

As with all research there are also some limitations. We used student data that may not readily generalize to employees, although it has been argued that student samples can be valuable when studying underlying processes of work-related experiences (Greenberg, 1987). To increase generalizability to the business world, however, our sample was comprised of only business majors. An advantage of this study design is that many students may perceive a significant sense of ownership and investment in their personal educational experience. Still, an important next step is to analyze the same research questions in an organizational setting. Second, all of our data is from one source and thus is subject to potential common method variance. While we addressed this to the degree possible, future research would benefit from the incorporation of data from a unique source such as a supervisor.

There are many opportunities for future research. Future studies could expand the number of team interpersonal processes examined to see if they are also moderated by communication medium experience in virtual teams. Moreover, Channel Expansion Theory suggests that the experiences of the team members with each other and with working together as a team could play important roles in the development

of these interpersonal processes beyond their experience with the technology. Further, work needs to be conducted to link these constructs to actual virtual team performance outcomes (i.e., beyond perceptual measures). Longitudinal investigations of how cohesion and openness in virtual teams develop over time are also needed. Other interesting avenues may be to expand our model to include visual thinking and logic skills as part of the knowledge process and directly capture the element of trust with the team.

In conclusion, virtual teams are a way of life in many organizations today and learning how to best utilize these teams is critical to team performance. As technology changes and becomes more pervasive, so too does the availability of new means of communication, new capabilities to existing media, and people's experience with and ability to use these computer-mediated technologies. In the midst of all of this change, there continues to be a role for extant team constructs and relationships in predicting and explaining virtual team activity. Our research supports the importance of team interpersonal processes on team outcomes as well as a role for experience with CMC media in enhancing these outcomes.

ACKNOWLEDGMENT

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APPENDIX

Survey Items

Team Cohesion

1. I look forward to being with the members of my team each day.
2. We tell each other the way we are feeling
3. I feel I am really a part of my team.

Team Openness

1. In my team everyone's opinion gets listened to.
2. If we have a decision to make, everyone is involved in making it.

Team Effectiveness

1. I performed better on this activity in my team than I would have by myself.
2. My team was effective at working through this activity.
3. I think my team will score above the average for all teams completing this activity.
4. I was able to make a real contribution to my team during this activity.

IM Experience

1. I am very experienced using communicating using IM.
2. I feel that communicating using IM is easy.
3. I feel competent using IM to communicate with others.
4. I believe that I am a "skilled communicator" when using IM.
5. I feel comfortable using IM to communicate with others.

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