

Team Learning and Effectiveness in Virtual Project Teams: The Role of Beliefs about Interpersonal Context

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There has been increasing interest in team learning processes in recent years. Researchers have investigated the impact of team learning on team effectiveness and analyzed the enabling conditions for the process, but team learning in virtual teams has been largely ignored. This study examined the relationship between team learning and effectiveness in virtual teams, as well as the role of team beliefs about interpersonal context. Data from 48 teams performing a virtual consulting project over 4 weeks indicate a mediating effect of team learning on the relationship between beliefs about the interpersonal context (psychological safety, task interdependence) and team effectiveness (satisfaction, viability). These findings suggest the importance of team learning for developing effective virtual teams.

Keywords: team learning, beliefs about the interpersonal context, team effectiveness, virtual teams

En los últimos años, se ha producido un creciente interés por los procesos de aprendizaje grupal en equipos de trabajo. Se ha investigado la influencia del aprendizaje de equipo en la efectividad grupal, así como las condiciones que facilitan dicho aprendizaje. Sin embargo, pocos trabajos han analizado los procesos de aprendizaje en equipos virtuales. Este estudio examina la relación entre aprendizaje de equipo y efectividad en equipos virtuales, así como el papel de las creencias compartidas sobre el contexto interpersonal en esta relación. 48 equipos desarrollaron un proyecto de consultoría de manera virtual durante cuatro semanas. Los resultados mostraron un efecto de mediación del aprendizaje de equipo en la relación entre las creencias sobre el contexto interpersonal (seguridad psicológica, interdependencia de tarea) y la efectividad grupal (satisfacción, viabilidad). Estos hallazgos sugieren la importancia del aprendizaje de equipo para desarrollar equipos virtuales efectivos.

Palabras clave: aprendizaje de equipo, creencias sobre el contexto interpersonal, efectividad de equipo, equipos virtuales

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Contemporary organizations operate in fast-changing environments. Given these conditions, the learning that takes place in project teams is essential because it represents a cognitive precursor to adaptation by the organization (Ilgen, Hollenbeck, Johnson & Jundt, 2005). In recent years, there has been a significant increase in the number of studies conducted in the area of team learning. Project teams create valuable knowledge and understandings for organizations through team learning, and at the same time their members' professional development is enhanced (Huber, 1991; Senge, 1994).

In particular, researchers have sought to identify the conditions that enable team learning (e.g. psychological safety; Edmondson, 1999), as well as the resulting benefits for the team effectiveness (e.g. team performance; Van den Bossche, Gijsselaers, Segers & Kirschner, 2006), which has traditionally been defined in terms of outcomes, including criteria such as productivity, innovation, satisfaction and viability (Hackman, 1990; Mathieu, Maynard, Rapp & Gilson, 2008). Nevertheless, most studies about team learning have been conducted on teams whose members can interact and cooperate in person (referred to as "face-to-face teams" in this paper). As a result, little is known about how team learning is produced in virtual project teams (VPTs) and what its effects may be. Virtual teams have become a basic unit of work in many organizations in response to the pressure to innovate, to foster inter-organizational alliances, and also to respond to the globalization of business and the adoption of new information technologies. VPTs allow companies to reduce the geographic, time-related and functional barriers to doing business, making them more efficient (Kayworth & Leidner, 2001-2002; Martins, Wilson & Maynard, 2004; Montoya-Weiss, Massey & Song, 2001; Schiller & Mandviwalla, 2007). Recently, it has been recognized that project teams can carry on their tasks at many different levels of virtuality (Kirkman & Mathieu, 2005), as they tend to alternate between virtual and face-to-face working. This idea that virtual interaction falls along a continuum has taken over from the conventional, dichotomous concept of face-to-face vs. VPTs.

Team virtuality has been described in terms of three basic dimensions (Kirkman & Mathieu, 2005): (a) the extent to which team members use virtual tools to coordinate and perform team processes; (b) the amount of informational value provided by such tools; and (c) the synchronicity of team member virtual interaction. Various conditions must be met if virtual interaction in a project team is to yield a high level of performance. For example, the media richness theory explains the correct use of information technology according to the task type (Daft & Lengel, 1986), the adaptive structuration theory emphasizes the appropriate application of information technology (DeSanctis & Poole, 1994), and the social

processing theory (Salanick & Pfeffer, 1978) posits the importance of considering not only the characteristics of the information technology itself, but also the users' attitudes, norms and behaviors.

With this in mind, the main objective of this study is to examine team learning processes in VPTs that work at a high level of virtuality. First, we analyze the relationship between learning behavior and effectiveness of VPTs in terms of team performance, satisfaction and viability. Next, we examine the role of beliefs about the interpersonal context in that relationship. The results will contribute to expand the current small body of evidence on team learning in virtual teams, enriching our understanding of the conditions that facilitate team learning and its possible benefits.

Team Learning and Effectiveness in Virtual Project Teams

Traditionally, team learning has been defined in terms of process (e.g. Alcover, Gil & Barrasa, 2004; Ellis, Hollenbeck, Ilgen, Porter, West & Moon, 2003; van Offenbeek, 2001) and outcomes (e.g. Edmondson, 1999; Van den Bossche et al., 2006; Wong, 2004). This study will build upon the pioneering work of Edmondson (1999) by adopting the notion that team learning is both process and outcome.

On the one hand, team learning is defined as a continuous process of reflection and action directed toward obtaining and processing information in order to detect, understand and adapt to changes in the environment, and also to improve project teams' performance and outcomes (Edmondson, 1999). This process manifests itself as a series of behaviors that members of the team exhibit, including asking questions, seeking feedback, experimenting, reflecting on results and discussing errors or unexpected situations. On the other hand, team learning is defined as a result when it improves performance and efficiency (Edmondson, Dillon, Roloff, 2007; Wilson, Goodman & Cronin, 2007).

Empirical research has provided evidence of a positive correlation between team learning behavior and team effectiveness (e.g. Chan, Pearson & Entekin, 2003; Wong, 2003). Edmondson (1999) found that learning behavior predicts team performance within organizations in different industries. Also, she observed that learning behaviors facilitate the successful implementation of new technologies for health care teams (Edmondson, 2003b). Recently, team learning has been related to other aspects of team effectiveness besides performance. For example, Van den Bossche et al. (2006) have found a positive correlation between team learning and viability for student project teams. Zellmer-Bruhn and Gibson (2006) have observed that

team learning increases the level of satisfaction among the members of multinational teams. Despite these important contributions, all of these studies about team learning have been conducted in face-to-face contexts, and so the extent to which those results can be generalized to project teams that work and interact virtually remains unknown.

In light of the findings obtained about face-to-face project teams, team learning could be essential to teams that work virtually, because a project team's performance is likely to improve when the understanding of dispersed members is better integrated. People also tend to feel more satisfied working in a virtual project team that allows them to acquire knowledge and achieve professional and personal goals. Moreover, team learning may reinforce viability by turning the project team into an attractive venue for long-term, efficient collaboration. Hence, we hypothesize the following:

Hypothesis 1: Team learning behavior will be positively related with VPTs' effectiveness in terms of performance (H1a), satisfaction (H1b), and viability (H1c).

Beliefs about Interpersonal Context

Researchers have paid increasing attention to the enabling conditions of team learning in recent years (Gibson & Vermeulen, 2003; van der Vegt & Bunderson, 2005). Particularly, beliefs about interpersonal context, defined as "a combination of shared perceptions that emerges among team members about the nature of relations that exists between them" (Edmondson, 1999; Van den Bossche et al., 2006), have attracted particular attention. These beliefs guide interactions between the members of a project team, and especially actions oriented toward team learning.

Following Edmondson (1999) and Van den Bossche et al. (2006), in this study we analyzed psychological safety, task interdependence and collective efficacy as beliefs about the interpersonal context that may enable team learning in VPTs.

Psychological Safety

Psychological safety is defined as a shared belief among team members that the team is safe for interpersonal risk taking (Edmondson, 1999). In psychologically safe teams, people feel free to ask questions, seek feedback, or discuss errors in their work, because they do not expect to be penalized or thought less of. However, the members of "unsafe" teams tend to silence their doubts and errors, and avoid talking about important issues, which in turn reduces their opportunities to learn from each other and adversely affects the team's performance (Edmondson, 2003a). Several studies have demonstrated the positive link

between psychological safety and team learning in face-to-face teams. Edmondson (1996) found that health care teams differed in their management of errors at work as a function of their level of psychological safety. Based on Edmondson's arguments (1996, 1999), West (2002) suggested that teams with higher levels of psychological safety create a climate where people feel comfortable about learning, innovating and managing conflicts constructively. In this line, Nembhard and Edmondson (2006) have observed that psychological safety is related with collaborative learning and commitment to doing high-quality work.

Very few studies have so far explored the role of psychological safety in VPTs. Psychological safety could neutralize the barriers imposed by virtual interaction (geographic dispersion, restricted communication, etc.) by facilitating more open, spontaneous communication between team members, and by reinforcing interpersonal trust, which would also increase team learning (Gibson & Gibbs, 2006; Griffith & Neale, 2001). Recently, Shepers, De Jong, Wetzels & De Ruyter (2008) have found that psychological safety predicts the adoption and use of different technologies in student VPTs. Based on these findings, the members of VPTs with a high level of psychological safety are expected to collaborate and share their understandings and experiences, thereby promoting team learning and effectiveness. Then, we predict that:

Hypothesis 2a: Psychological safety will be positively related with team learning behavior in VPTs.

Task Interdependence

A project team exhibits task interdependence when its members perceive that their own actions and results are strongly affected by the actions and results of the rest of the team (Johnson & Johnson, 1989). Task interdependence influences the extent to which people believe they are collectively responsible for the team's goals, and involves an awareness of the need to collaborate extensively in order to do a good job. Previous studies indicate that task interdependence facilitates team processes such as cooperation and helping behavior (van der Vegt, Emans & van der Vliert, 2001; Wageman, 1995). Similarly, Van den Bossche et al. (2006) found that task interdependence predicts learning behavior in student project teams.

Nevertheless, the relationship between task interdependence and team learning has still not been investigated in the context of VPTs. As has been observed in face-to-face teams (De Dreu, 2007), when a shared perception of mutual dependence exists within a virtual team, members may learn collectively and perform their jobs better by managing conflicts and sharing information in an efficient manner. In contrast, if members of VPTs believe they can perform their task independently, they

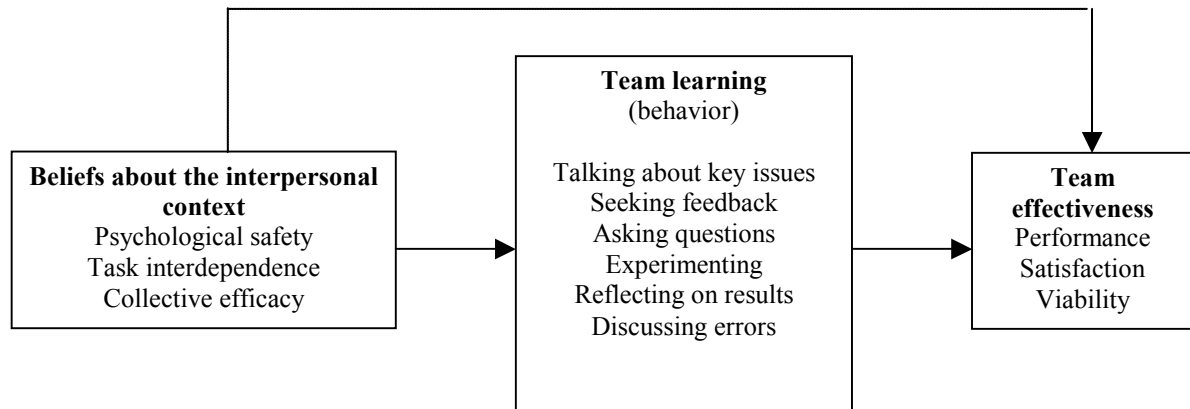


Figure 1. Team learning and virtual team effectiveness model.

will not find useful to interact and cooperate with one another, which will decrease team learning behavior. Thus, we expect that:

Hypothesis 2b: Task interdependence will be positively related with team learning behavior in VPTs.

Collective Efficacy

Collective efficacy refers to a team's shared belief in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments (Bandura, 1997). Research has demonstrated that collective efficacy predicts team performance in both face-to-face (Lent, Schmidt & Schmidt, 2006; Tasa, Taggar & Seijts, 2007; Watson, Chemers & Preiser, 2001) and VPTs (Fuller, Hardin & Davison, 2006; Salanova, Llorens, Cifre, Martínez & Schaufeli, 2003). However, there has been hardly any research on the effects of collective efficacy on team learning. Edmondson (1999) found a positive link between collective efficacy and team learning behavior in teams in larger organizations. Furthermore, it has been suggested that collective efficacy helps VPTs to see themselves as capable of overcoming the difficulties associated with working virtually (González, Burke, Santuzzi & Bradley, 2000). Consequently, VPTs with a high level of collective efficacy are likely to share understanding and learn together in the belief that they can successfully accomplish the work at hand. Hence, we hypothesize that:

Hypothesis 2c: Collective efficacy will be positively related with team learning behavior in VPTs.

The Mediating Role of Team Learning

Recent studies have posited that team learning is a key mediator in explaining the relationships between different

project teams' characteristics and results (Kozlowski & Ilgen, 2006; Mathieu et al., 2008; Van den Bossche et al., 2006). Edmondson (1999) found that learning behavior mediates the relationship between psychological safety and team performance for teams in a manufacturing company. Also, van der Vegt and Bunderson (2005) found that team learning mediates the relationship between expertise diversity and team performance in multidisciplinary project teams. More recently, De Dreu (2007) reported that team learning mediates the effect of cooperative interdependence on team effectiveness.

Under highly virtual conditions, which require every member to respond and adapt to his or her environment, team learning behavior may mediate the relationship between beliefs about interpersonal context and team effectiveness. Thus, psychological safety, task interdependence and collective efficacy will increase team learning, which will in turn increase the performance, satisfaction and viability of VPTs (see Figure 1). Nevertheless, we propose that there is a partial (*vs.* full) mediating effect because beliefs about interpersonal context could also influence the results of VPTs not only through learning behavior, but also through other team processes such as communication and conflict management. Thus, we hypothesize that:

Hypothesis 3: Team learning behavior will partially mediate the relationship between beliefs about interpersonal context and the effectiveness of VPTs.

Method

Participants

The study involved a total of 144 participants, who were grouped into 48 teams of three members each. The participants were final year psychology students at a large

Spanish university. The mean age was 22.5 years and 82% of the participants were women. The students participated in the study as a requirement for a particular course, which determined 40% of their final grades. All members of the project teams reported on the variables of the study.

Task

The team task consisted of advising the managers of a fictitious company about how to resolve its internal functioning problems. Each team received a document describing the company's problems (communication processes, the structure of different parties' roles and leadership). Teams were asked to analyze the situation, discuss it and write a final report including a diagnosis of the problems and an intervention plan. To perform this task, team members could only communicate using the tools provided by the course's Virtual Campus, accessed via the university's intranet system (forum, chat and email).

Procedure

Participants were randomly assigned to one of the project teams. All teams were homogeneous in size, task type, age, level and type of studies (major), nationality, task expertise (all of the participants performed the task for first time) and familiarity (in each team, members did not know each other previously). This allowed us to control to some extent several variables that could have importantly influenced the VPTs' processes and results (Jackson, Joshi & Erhardt, 2003).

Once the VPTs were formed, their members performed the assigned work in two 90-minute sessions per week over the course of four weeks. In the first week, cases were assigned to each team through the Virtual Campus e-mail system, which members could access by entering a username and password. Team members met for the first time via the chat-room, which provided a space for them to get to know each other and organize. In the second week, teams formulated questions about the case to increase the available information on the company. The questions were answered via email by research assistants. In the third week, teams discussed the case and began to write up their reports on the company. In the final week, teams were asked to submit their reports, and to fill out a questionnaire designed to evaluate the study variables.

Each team member worked in an individual, independent cubicle equipped with a personal computer. The cubicles were located in different classrooms and the computers were connected to the university's intranet system so that they could access Virtual Campus. Two research assistants supervised the teams' performance.

Measures

With the exception of team performance, all of the study variables were evaluated by a questionnaire that was completed by all members of each team. The items on the questionnaire used a 5-point Likert response scale (1 = *totally disagree*, 5 = *totally agree*).

Team learning was measured by 5 items from a scale developed by Edmondson (1999) to assess team learning behavior. A sample item is: "We regularly take time to figure out ways to improve our team's work processes" ($\alpha = .64$). Although the original scale consisted of 7 items, two were eliminated on our final scale due to their poor psychometric behavior. This could be because the scale was originally designed to evaluate learning in teams within real organizations, which differ notably from the VPTs examined in this study.

Psychological safety was evaluated by the 7 item-scale also developed by Edmondson (1999). One item on the scale is, "If you make a mistake in this team, it is often held against you" ($\alpha = .67$). This alpha coefficient is similar to that observed in prior studies (Cannon & Edmondson, 2001; Van den Bossche et al., 2006).

Task interdependence was evaluated by 4 items adapted from a scale by van der Veegt et al. (2001). Items include, "I depend on my teammates for the completion of my work" ($\alpha = .63$). The value of the alpha coefficient is similar to that found in earlier studies (Van den Bossche et al., 2006).

Collective efficacy was measured by 5 items from Bandura's (1986) efficiency belief scale, adapted by Jung and Sosik (2002) for use in evaluating teams. A sample item is, "Our team can find solutions to problems with its performance" ($\alpha = .79$).

Team performance was assessed by three independent judges who were unaware of the study's objectives (research assistants), and who scored the teams' reports applying two criteria: 1) organization, reflecting the extent to which the proposal is well-structured and provides an adequate solution to the problem; and 2) depth, reflecting the extent to which the proposal explores in detail the different issues involved in the company's problems (Rico, Molleman, Sánchez-Manzanares & van der Veegt, 2007). The judges assigned a score for each criterion ranging from 0 (very low) to 10 (very high). Given that the inter-judge consistency measured by a within-class correlation coefficient was acceptable (.75 and .89 for organization and depth, respectively), we were able to compute an average of the judges' scores for each performance criterion. Also, a strong correlation was observed between scores on the two criteria for performance ($r = .84$; $p < .01$), and we therefore averaged the scores to obtain a single performance score for each team.

Satisfaction was measured by 3 items adapted from the Gladstein's satisfaction scale (1984). Items include, "I love the way my team members and I work together" ($\alpha = .83$).

Viability was evaluated by the following item designed by Lewis (2004) based on Hackman's work (1990): "If I had to participate in another project like this one, I would like to work with the same team again."

Control Variable

Perceived virtuality was considered a control variable in this study since a high level of virtual interaction was a necessary requirement for the teams studied, and because variability in members' perceived virtuality could affect the results. This variable was measured by 4 items taken from the virtuality scale used in previous research on virtual teams (Cohen & Gibson, 2003; Rico, Cohen & Gil, 2006). The items evaluated the extent to which members of the virtual teams depended on different communication tools to do their work. For example, one item is, "To what extent did your project team depend on email to communicate?" ($\alpha = .70$). Also, participants indicated the average percentage of the time they communicated using each different type of information technology.

Aggregation of Measures

All of the variables in the present study were analyzed at the team level. Team learning, psychological safety, task interdependence and collective efficacy were all referent-shift consensus measures, while satisfaction and viability were direct consensus measures (Chan, 1998). Accordingly, we assessed the degree of within-team agreement for each of the measures before aggregating them using a consistency-based approach (computation of

ICC[1]) in combination with a consensus-based approach (computation of $AD_{M(j)}$ index; González-Romá, Peiró & Tordera, 2002).

Table 1 presents the results of the aggregation analysis. The mean values on the ICC(1) ranged from .20 to .39, which complied with the usual criteria for inclusion employed in prior research (González-Romá et al., 2002). The mean values on the $AD_{M(j)}$ ranged from .42 to .51, which were below the .83 acceptable level (for a 5% significance level with five response options and three raters from each team; Dunlap, Burke & Smith-Crowe, 2003). Also, the results of a one-way ANOVA revealed significant between-teams differences in the means of all the scales ($p < .01$) with the following F values: team learning (2.5), psychological safety (1.9), task interdependence (1.6), collective efficacy (1.6) and satisfaction (1.6). These results suggest that the scales exhibit adequate within-team agreement and between-team differentiation to warrant aggregation.

Results

Table 1 shows the descriptive statistics and correlations between all the variables in the study. In support of our Hypotheses 1a-1c, team learning was positively and significantly related with team performance ($r = .35, p < .05$), satisfaction ($r = .45, p < .05$) and viability ($r = .48, p < .05$). In line with Hypotheses 2a-2c, psychological safety ($r = .39, p < .01$), task interdependence ($r = .62, p < .01$) and collective efficacy ($r = .52, p < .01$) were positively and significantly related with team learning. Perceived virtuality was not correlated with any other variable included in the analysis.

Table 1
Means, Standard Deviations, and Correlations between Study Variables

Variable	ICC(1)	$AD_{M(j)}$	M	SD	1	2	3	4	5	6	7	8
1. Perceived Virtuality	.39	.33	4.70	.35	.70							
2. Psychological Safety	.23	.42	3.93	.41	.04	.67						
3. Task Interdependence	.20	.47	3.40	.55	-.01	.51**	.64					
4. Collective Efficacy	.20	.47	3.23	.50	.14	.45**	.40**	.79				
5. Team Learning	.33	.51	3.07	.49	.09	.39**	.62**	.52**	.64			
6. Team Performance			7.46	2.01	-.06	.08	.30*	-.05	.35*			
7. Satisfaction	.20	.48	3.50	.54	.08	.36**	.40**	.53**	.48**	.10	.83	
8. Viability	.20	.48	3.43	.72	.16	.43**	.42**	.70**	.48**	-.06	.62**	†

Note. † Only one item in the scale, $N = 48$ teams.

* $p < .05$. ** $p < .01$.

Table 2

Results of the Hierarchical Regression Analyses Testing for Mediation Effect of Team Learning

	Team Learning			Satisfaction			Viability		
	b	F	R ² _{adjusted}	b	F	R ² _{adjusted}	b	F	R ² _{adjusted}
Perceived Virtuality	.07	.38	-.01	.06	.29	-.01	.14	1.31	.00
Psychological Safety				.36*	3.5	.09	.42**	5.87	.17**
Psychological Safety	.39**	4.42	.12**						
Psychological Safety				.20	3.59	.03*	.28*	5.87	.17**
Team Learning				.40**			.33**		
Perceived Virtuality	.09	.38	-.01	.08	.29	-.01	.17	1.31	.00
Task Interdependence				.40**	4.59	.13**	.42**	5.98	.17**
Task Interdependence	.62**	14.59	.37**						
Task Interdependence				.17	4.59	.13**	.21	5.98	.17**
Team Learning				.37*			.33*		
Perceived Virtuality	.01	.38	-.01	.00	.29	-.01	.06	.31	.02
Collective Efficacy				.53**	9.09	.25**	.70**	23.17	.50**
Collective Efficacy	.51**	8.35	.23**						
Collective Efficacy				.39**	9.09	.25**	.61**	23.16	.48**
Team Learning				.27*			.15		

Note. $N = 48$ teams. The values are coefficients of standard regressions.

* $p < .05$. ** $p < .01$.

To test Hypothesis 3 about the partial mediating effect of team learning on the relationship between beliefs about the interpersonal context and virtual project team effectiveness, we followed the procedure established by Baron and Kenny (1986). As Table 2 shows, psychological safety ($\beta = .39, p < .01$) and task interdependence ($\beta = .62, p < .01$) were significantly related with team learning. Furthermore, the independent variables psychological safety and task interdependence were positively related with satisfaction ($\beta = .36, p < .01$; $\beta = .40, p < .05$) and viability ($\beta = .42, p < .01$). However, none of those variables were related with team performance. Finally, the coefficient of psychological safety ceased to be significantly related with satisfaction ($\beta = .20, p > .10$) and was diminished for viability ($\beta = .28, p < .05$) when team learning was included in the regression equation, while team learning was significantly related with satisfaction ($\beta = .40, p < .01$) and viability ($\beta = .37, p < .01$). Meanwhile, the task interdependence coefficient ceased to be significantly related with satisfaction ($\beta = .17, p > .10$) and viability ($\beta = .21, p > .10$), and team learning was significantly related with satisfaction ($\beta = .37, p < .05$) and viability ($\beta = .33, p < .05$). Results of the Sobel test (1982) showed that the indirect effects of psychological safety on satisfaction ($z = 2.03, p < .05$) and viability ($z = 1.96, p < .05$) were significant, as are the indirect effects of task interdependence on satisfaction ($z = 1.80, p < .05$) and viability ($z = 1.93, p < .05$).

Overall, our results partially support Hypothesis 3 about the mediating effects of team learning behavior. The

evidence indicates: (a) a partial mediating effect on the relationship between psychological safety and viability; and (b) a total mediating effect on the relationship between psychological safety and satisfaction, and on the relationship between task interdependence and both satisfaction and viability. Finally, the results do not support the expectation that there would be a mediating effect when collective efficacy is treated as an independent variable, or when team performance is treated as a dependent variable (see Table 2).

Discussion

The primary objective of this study was to examine team learning processes in the context of VPTs. We wanted to ascertain the relation between team learning behavior and team effectiveness, as well as the role of beliefs about the interpersonal context. Our results partially support the hypotheses posited in the research model outlined above, an important contribution to the literature on team learning and virtual teams.

First, our results provide empirical support for Hypothesis 1 about the positive relation between team learning behavior and effectiveness in VPTs, making a two-fold contribution towards expanding the team learning model proposed by Edmondson (1999). First, team learning behavior increased not only performance, but also the satisfaction and viability reported by members of VPTs. This enriches our understanding of how team learning

influences the effectiveness of virtual teams, particularly the team's viability, an aspect that had not previously been explored (Martins, Wilson & Maynard, 2004). Next, the study extends the general finding obtained with face-to-face teams that there is a positive link between team learning and performance to virtual teams. This suggests we can apply at least part of the substantial body of theory about team learning in face-to-face contexts to VPTs (Wilson et al., 2007).

Second, as described in Hypothesis 2, our results provide evidence for the relationship between beliefs about the interpersonal context and team learning in VPTs. In line with prior research, the results indicate that psychological safety stimulates interactions oriented towards learning in project teams that operate virtually, and not only in face-to-face teams (Griffith & Neale, 2001). Also, shared beliefs about task interdependence and collective efficacy seem to stimulate team learning among members of those teams. Taken together, these results suggest the importance of considering psychological safety, task interdependence and collective efficacy as possible antecedents to team learning in virtual teams. This is consistent with the available evidence about team learning processes in teams whose members work face to face (Edmondson, 1999; Van den Bossche et al., 2006). Furthermore, our findings agree with the principles of the adaptive structuration theory (DeSanctis & Poole, 1994) and task-technology fit theory (Goodhue & Thompson, 1995). In other words, the beliefs held by members of VPTs affect their learning behaviors, and reinforce the use and adoption of the technological tools that ultimately improve team effectiveness.

Finally, the results partially support Hypothesis 3 about the partial mediating effect of team learning. This means that team learning is an important team process that contributes to explain in part how beliefs about the interpersonal context, particularly psychological safety and task interdependence, can improve the effectiveness of VPTs in terms of their satisfaction and viability. Echoing the results reported by Edmondson (1999), however, the evidence does not support any mediating role of team learning when the independent variable is collective efficacy, or when the dependent variable is performance. This suggests that team learning exhibits a complex pattern of mediation, whose relationship with the beliefs and effectiveness of VPTs may depend on the specific criteria considered in evaluating the variables.

From an applied perspective, our findings highlight the importance of creating the right social conditions for project teams to work using virtual communication tools, and to optimize not only their outcomes, but also learning processes. To do so, organizations should facilitate learning in these project teams. For example, team leader coaching may reinforce teams' psychological safety, in turn

stimulating learning behavior (Edmondson, 2003b; Lewis, Tyran & Shepherd, 2003). Also, training programs could be designed that would teach people working in virtual teams to recognize and understand the key behaviors involved in team learning (seeking feedback, reflecting on results, etc.), and the team could then put them into practice with the assistance of a facilitator (Edmondson, Bohmer & Pisano, 2001). Other possible interventions to encourage learning in VPTs include holding initial face-to-face meetings, when the team has just been formed, planning regular work sessions, assuring a certain amount of stability in team composition and providing appropriate technologies for collaboration (Hinsz & Weisband, 2003).

This research contains a number of limitations. All the measures taken in this study, with the exception of team performance, were self-report scales answered by team members. Given that using the same method and the same rater to assess a study's variables can create a high level of common method variance, further research could complement the self-report questionnaire with other evaluation techniques, such as direct observation of learning behavior, or interviews with formal team leaders. Furthermore, a multiple-item scale could be used to evaluate team viability instead of the single-item scale that was used in the current study.

Also, our results cannot be applied directly to VPTs in real organizations because the study's participants were university students working through virtual interaction in a controlled, cooperative learning environment. If the aim of this study had been to create an initial approximation to empirical testing of the learning model for VPTs, then it would have been pertinent to take samples from real organizations' project teams, so that findings could be generalized to the population.

Finally, in this study, we have examined the relationships between three types of beliefs about the interpersonal context (psychological safety, task interdependence, and collective efficacy), learning behavior and effectiveness in VPTs. A future research direction would be to examine the conditions that facilitate the development of those beliefs (e.g. leadership style, organizational support, information technologies).

To sum up, this study was conducted in response to the lack of empirical research about the team learning processes in VPTs, and the conditions that facilitate team learning itself (Wilson et al., 2007). Our results suggest the relevance of team learning behavior to the effectiveness of VPTs, as well as the importance of shared beliefs about interpersonal context in stimulating learning behavior. As organizations increasingly rely on VPTs to operate, researchers have taken up the challenge of understanding the conditions that optimize learning and effectiveness for these teams.

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