Importance of Diversified Leadership Roles in Improving Team Effectiveness in a Virtual Collaboration Learning Environment

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Abstract

Virtual teams enabled by information and communications technologies (ICT) are increasingly being adopted not only by for-profit organizations but also by education institutions as well. This study investigates what contributes to the success of virtual learning teams. Specifically, we examine the issue of leadership in virtual learning teams. The study first reviews the current literature on teams, leadership, and trust then proposes a framework of team effectiveness of virtual learning teams. A field study is conducted to investigate the influence of several independent variables including diversified leadership roles, leadership effectiveness, team trust, and propensity to trust. It is found that diversified leadership roles influences both leadership effectiveness and team trust; both leadership effectiveness and propensity to trust influence team trust, and team trust in turn directly impacts team effectiveness. In addition, team trust mediates the relationship between leadership effectiveness and team effectiveness. Some practical implications of the results are discussed as well.

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Introduction

Advancements in information and communication technologies (ICT), specifically the use of Internet-based systems, have endowed people with the ability to work and learn remotely and virtually while retaining or superseding the performance of traditional teams. The trends of merger and acquisition, alliance, hyper-competition, downsizing, and globalization have pressured firms to locate the best talents around the world and group them to serve the firms' best interests (Kerber & Buono, 2004). The virtual team is becoming the basic work unit in the Information Age (Lipnack & Stamps, 1997).

Virtual teams differ from traditional face-to-face (F2F) teams primarily in virtual teams' heavy reliance on ICT as media for communication and as a link between people (Lipnack & Stamps, 1997). ICT links used by virtual teams can be either synchronous or asynchronous tools used to carry out interpersonal communications, collaboration and coordination (O'Hara-Devereaux & Johansen, 1994). Synchronous ICT tools vary in terms of social presence and information richness and can be classified as text-, audio- and video-conferencing systems. Asynchronous ICT tools range from e-mails, discussion forms, and bulletin boards, to workflow, scheduling and other project management applications.

Critical success factors for a virtual team are similar to those for a traditional team with respect to some essential elements. Teams in both forms need a clear purpose (Huszczo, 1996), measurable goals (Pape, 1997), appropriate

team size of 3-12 people (Lipnack & Stamps, 1997), establishment of team norms or operating guidelines (Scholtes, 1998), effective communication and decision making skills and processes (Aranda, Aranda, & Conlon, 1998). In addition, a strong leadership is also needed for the success of virtual teams (as in F2F teams). It is commonly agreed that a strong leadership is hard to establish in a virtual team. A shared or distributed leadership among team members rather than centralized leadership is more likely to achieve team success (Lipnack & Stamps, 1997). This means that team members need to have self-directing freedom to manage their team project in a collaborative fashion (Barry, 1991).

Despite the similarities, Hudson (2000) observes that a virtual team, unlike the F2F team, needs to address simultaneously at least three types of issues – pedagogical, technological and cultural. These three types of issues pose unprecedented challenges for people with diversified backgrounds (e.g., perspectives, approaches, and ideas) to work effectively together (Lurey & Raisinghani, 2001). In addition, many issues, such as team roles, leadership, power, trust (Greiner & Metes, 1995), time and distance, and organizational relationship building in virtual teams, are newly emerging and have not been readily addressed (Pauleen & Yoong, 2001).

This research chooses to address one of the three issues identified by Hudson (2000) as being important to virtual teams—pedagogical—in that we examine what contributes to the effectiveness of virtual learning teams in a university context. Specifically, this study investigates the relationships of leadership and trust, which have not been readily addressed (Pauleen & Yoong, 2001). These issues are chosen for two reasons. From an empirical perspective, based on a search of the literature there has been little or no study done on the effects of diversified roles of leadership in *virtual* teams (e.g., Kayworth & Leidner, 2002). From a theoretical perspective, although there have been studies on trust and virtual teams, there has been no study that integrates both diversified leadership roles and trust issues in a single framework to be investigated. To address this gap in the literature, this study first develops an integrated theoretical framework of team effectiveness taking into account both diversified leadership roles and trust issues then empirically investigates the framework.

In the context of university learning, a virtual team made of student members taking a course in a semester or shorter duration are quickly assembled and disassembled. Here, the primary goals of a virtual team are to improve grades for a team project and grades for individual members. This study investigates the antecedents to the effectiveness of virtual learning teams. We carry out a field study to investigate the influence of several independent variables and deliberately have team members interact with each other virtually via a wide variety of ICT media. The control of virtual environments allows us to focus our attention on some key elements—leadership effectiveness, team trust, propensity to trust, and team effectiveness. The results of this study and its practical implications are also discussed.

Theoretical model

Leadership roles in the virtual team

The behavioral complexity theory of leadership stresses the importance of a leader exhibiting diversified leadership roles in order to improve team effectiveness (Kayworth & Leidner, 2002). Other researchers address the leadership roles based on the complexity of environment (Jessup, 1990). Mintzberg (1973) asserts that a manager alternates among ten leadership roles swiftly to cope with daily challenges. These ten roles can be classified into three categories: (1) interpersonal contact, (2) information processing, and (3) decision making. In contrast, Jessup (1990) summarizes leadership roles into administrator, coach and adviser. In addition, Denison, Hooijberg, and Quinn (1995) posit that an efficient leader can simultaneously play diversified and sometimes competing leadership behaviors in order to respond to rapid changes of internal and external environments and define this competing behavior as "behavioral complexity" (p. 526).

Leaders in the prevalent virtual teams are facing new challenges, such as ICT-enabled communications, cross-cultural communications, global logistical design, technological complexity (Kayworth & Leidner, 2002), information overload, lack of social cues (Hallowell, 1999), and fast creation of camaraderie (Johnson, 2000). In a virtual setting, the need for an effective leader to recognize differences among team members is even greater than that in F2F settings. Employing members' talents to achieve synergy and communication synchronization as well as managing member and leader expectations in an effective way is a daunting task. This study capitalizes on the

leadership complexity theory and posits that an effective leader in the virtual learning team also needs to assume diversified leadership roles in order to achieve success in project performance.

Predictors of leadership effectiveness

Quinn's (1984) Model of Leadership Roles places eight leadership roles along two dimensions—stability vs. flexibility and internal focus vs. external focus—in order to explain the opposing behaviors of an effective leader. For instance, innovator and broker are leadership roles that fit into a business environment where flexibility and external focus are critical success factors. A leader with an open mind is more receptive to challenges in this business environment. When stability and rationalization are the goals of an organization, an effective leader needs to be a producer to maximize output and a director to lead projects with clearly articulated goals. In addition, an effective leader needs to have interpersonal skills to harmonize internal and external relationships; here the roles of facilitator and mentor help improve communication and solidify relationship among team members. All in all, an effective leader needs to recognize the roles of his or her behaviors and play competing leadership roles delicately in order to deal with the complexity of the real world (Quinn 1984; Hart & Quinn 1993; Hooijberg 1996).

A higher degree of stability is more retainable in an e-learning environment than in a business environment because course objectives are clearly defined by instructors in the syllabus and other variables are much more controllable. For instance, students who register in the same course have similar characteristics, such as having completed identical prerequisite courses, possessing common learning interests, and having similar educational backgrounds. However, because learning paths taken to achieve learning goals vary with individuals and teams the learning process can be either internal- or external-centered. For example, when a student team receives a case study assignment, team members may choose to analyze the case by using secondary data shown in the case or by conducting actual interviews with managers of the case firm. Thus an effective leader in the virtual learning collaboration environment needs to pay special attention to the exercise of leadership roles in the internal-stable and external-stable quadrants of Quinn's (1984) model. What is unclear to us is what effects on the learning outcomes can these leadership roles—producer, director, monitor and coordinator—have? This research seeks to investigate the efficacy of diversified leadership roles on leadership effectiveness in the virtual learning collaboration environment.

H1: A leader has higher leadership effectiveness when exhibiting diversified leadership roles in a virtual team.

Dynamics of trust in virtual teams

Trust is a multi-faceted factor that has been studied in many fields, including organizational science, economics, psychology and marketing. Two perspectives dominate the literature on trust: rational and social. From the *rational* perspective, trust is treated as the collective intangible asset embedded in the relationship (Fukuyama, 1995). Here trust is seen as an interpersonal state when two individuals cooperate rather than compete, despite the risk of an individual exploiting the cooperation to his or her advantages (Deutsch, 1958; Mayer, Davis, & Schoorman, 1995). Thus rationally, a higher degree of trust can potentially minimize the opportunistic behavior of exploiting vulnerabilities and create a win-win situation.

From the *social* perspective, social exchange theory deals with the interpersonal exchange of intangible social costs and benefits (Kelley & Thibaut, 1978). Thus, reciprocal rewards and the success of a social exchange process depend on the beliefs of the exchange partners (Blau, 1964). Team members need to have the strong belief—trust—at the outset of team formation in order to facilitate the social exchange process. Team trust is a function of perceived ability, integrity, and benevolence as well as the propensity of members to trust each other in the virtual team (Jarvenpaa, Knoll, & Leidner, 1998). This social perspective of trust is different from the rational perspective focusing on the calculation of self-interests. The latter perspective is harder to achieve in virtual settings because many social contexts cannot be precisely incorporated into the rational calculation process.

In the F2F environment, trust is an influential factor for sound working relationships (Bhattacharyam, Devinney, & Pillutla, 1998), more open communication (Smith & Barclay, 1997), intensive collective knowledge creation activities (Solomam, 2001), a higher degree of cooperation (Parks, Henager, & Scamahorn, 1996), improvement in

the quality of decision-making processes (Zand, 1971), a higher satisfaction level with the decision-making process (Driscoll, 1978), and a more risk-taking environment (McKnight & Chervany, 2000). An increase of physical and psychological distance among team members (O'Hara-Devereaux & Johansen, 1994) and the necessity of building trust at the outset of virtual team formation further substantiate the importance of trust issues in virtual teams. The novel contribution of this study is the simultaneous investigation of both trust and leadership issues in a single theoretical framework.

Leadership and team trust

To be an effective leader and to effect actions, a leader needs to articulate visions clearly, embody values and create the environment to accomplish things together with team members. Drath and Palus (1994) concur with this assertion by defining leadership as "the process of making sense of what people are doing together so that people will understand and be committed." (p. 4) However, Denison, Hooijberg, and Quinn (1995) state that a leader still needs to "…exhibit contrary or opposing behaviors (as appropriate as necessary) while still retaining some measure of integrity, credibility, and direction." (p. 526) In other words, in a virtual environment a leader still needs to play diversified leadership roles, have the interpersonal skills to harmonize relationships, exhibit roles of facilitator and mentor to help improve communication and solidify relationships among team members, and shift to producer-like roles when project deadline nears. This research newly posits that there is a relationship between diversified roles exhibited by the leadership and trust in a virtual team.

H2: Trust among team members can be improved when a leader exhibits diversified leadership roles in a virtual team.

In addition, the literature shows that leadership is an important critical success factor for team cooperation (Jarvenpaa, Knoll, & Leidner, 1998; Jarvenpaa & Leidner, 1999; Kayworth & Leidner, 2002; Avolio & Kahai, 2003; Hart & Mcleod, 2003; Zigurs, 2003). In a team situation, a leader is needed to execute a project plan, supervise project progress, and handle project obstacles (Duarte & Snyder, 1999). However, in a virtual team situation, the leader relies extensively on ICT to communicate with members and to disseminate information, and a leader's dependence on ICT as a primary communication means could weaken his or her ability as a leader in a virtual team (Avolio & Kahai, 2003). Thus, an effective strategy for a leader is to actively build relationships among team members and to encourage members to do the same with each other. This strategy can help improve overall trust (Pauleen, 2003). Furthermore, positive leadership can quickly build trust and continuously maintain trust relationships (Jarvenpaa, Knoll, & Leidner, 1998; Jarvenpaa & Leidner, 1999). Therefore, although prior studies have hinted at an association between a leader's effectiveness and team trust, this study specifically posits the existence of such a relationship.

H3: Leadership effectiveness established by a leader can improve trust among team members in a virtual team.

Team trust and team effectiveness

Jarvenpaa and Leidner (1999) assert that to succeed in virtual teams, a higher level of trust needs to be established in the beginning and ending periods of a project. In a virtual environment, Lipnack and Stamps (1997) studied the critical success factor of virtual teams at IBM, Sun Microsystems and Motorola and discovered that trust is the prerequisite to the success of virtual teams. Although this study generally concurs with the literature on the positive relationship between trust and team effectiveness, this research specifically investigates whether or not trust directly contributes to team effectiveness in an e-learning setting.

An effective surrogate of measuring team effectiveness is a team's learning performance and satisfaction. Two major measures of team effectiveness include performance and attitudinal indicators. The performance indicator is concerned with the percentage of goals achieved while the attitudinal indicator is concerned with team relationships (Gladstein, 1984; Lurey & Raisinghani, 2001). The former indicator can be measured subjectively (Lurey & Raisinghani, 2001; McDonough, Kahn, & Barczak, 2001) or objectively (Gladstein, 1984) to gauge if project goals (e.g., scheduling, scope, budget, and quality) have been achieved. The latter indicator can be assessed using satisfaction measurements in cooperation, team, team members, job (Gladstein, 1984), results (Warkentin, Sayeed, &

Hightower, 1997), and decision making process (Paul et al., 2004). Lipnack and Stamps (1997) found that trust is the prerequisite to the success of virtual teams. Building upon prior literature, this study adopts both performance and attitudinal indicators to assess team effectiveness. Thus,

H4a: Higher trust among team members can lead to higher team performance of team members in a virtual team.

H4b: Higher trust among team members can lead to higher team satisfaction of team members in a virtual team.

Note that as a consequence of H3 and H4, team trust becomes structurally a mediating variable between leadership effectiveness and team effectiveness (see Figure 1). In other words, the relationship between leadership effectiveness and team effectiveness is then a function of team trust. The mediating role of team trust makes sense conceptually because it is widely agreed that when a leader is effective, he or she will have lasting impacts on members and cause them take actions to achieve team's goals (Bass, 1981); but if team members do not trust each other, then it is difficult for a leader to exert influence on team success regardless of how effective the leader is. Therefore, this research specifically explores whether team trust mediates the relationship between leadership effectiveness and team performance.

H5a: Team trust mediates the relationship between leadership effectiveness and team performance of team members in a virtual team.

H5b: Team trust mediates the relationship between leadership effectiveness and team satisfaction of team members in a virtual team.

Propensity to trust and team trust

Cattell (1974) defines personal orientation as persistent reflection orientation, the fundamental unit of personality. Propensity to trust or disposition to trust is a persistent reflection orientation or personality. Evidences of trust can be found in intention, capability, reliability, reputation, and benevolence, and a trustor can observe these evidences to decide if he or she wants to trust another or others (Mayer, Davis, & Schoorman, 1995). Gill et al. (2005) agrees with Mayer, Davis, and Schoorman's (1995) proposition that capability, benevolence and integrity are predictors of trust intention. In addition, degrees of trust orientation can help explain new and ambiguous information (Kahneman & Tversky, 1973). When an individual has a strong belief in human nature (high trust orientation), he or she will selectively choose information that is consistent with trust orientation and interpret this information accordingly (McKnight, Cummings, & Chervany, 1998). Individuals with high trust orientation or propensity to trust can naturally have a higher trust in team, team members and its leader.

H6: The higher propensity of team members to trust each other, the higher trust among team members in a virtual team.

This research specifically incorporates propensity to trust as an antecedent to team trust in the theoretical framework because propensity to trust is a "leading indicator" that can be assessed prior to the formation of teams. The practical implications of this relationship are discussed further in Section 5.

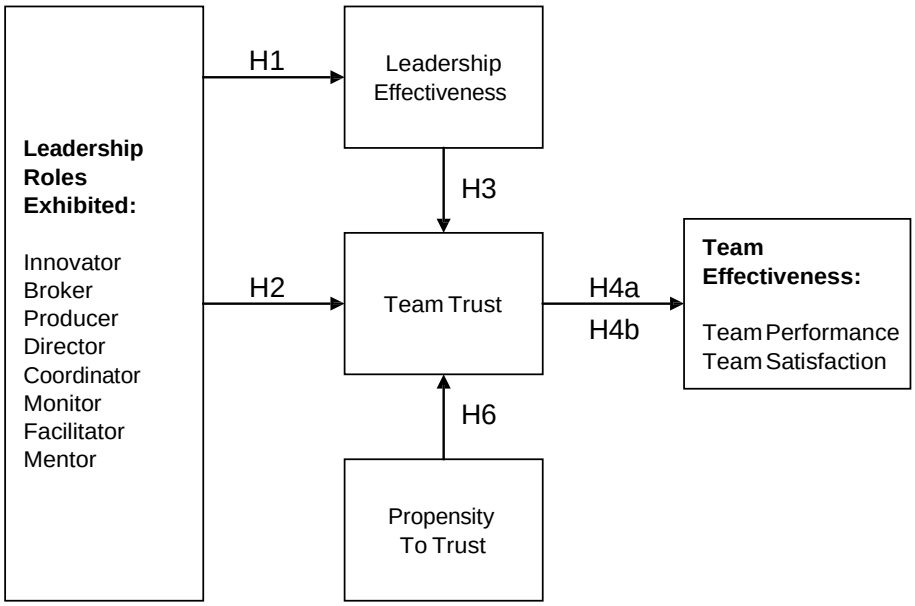
The theoretical framework is show in Figure 1.

Research methodology

Procedure

To investigate the proposed theoretical model, we conducted a field study (Cook & Campbell, 1979) to collect data and to test the hypotheses in the context of an online course. The subjects consisted of 178 undergraduate students who enrolled in an online management of information systems (MIS) course at a private university in Taiwan. This course was delivered completely online, except for three F2F meetings held by the instructor. The first F2F meeting

was for the instructor to introduce the course and to demonstrate the use of the course e-learning system and ICT media. The second and the third F2F meetings were for midterm and final examinations.



H5a: Team trust mediates between leadership effectiveness and team performance

H5b: Team trust mediates between leadership effectiveness and team satisfaction

Figure 1. Theoretical framework

The subjects were randomly assigned to 14 virtual learning teams, each team consisting of between 12 to 13 members. Team designations (labels) were impersonal and in numerical order. After the first F2F meeting, the instructor sent an e-mail to all the subjects telling them to read a message posted on the course e-learning system's bulletin board. This message detailed the process of how the team project is to be carried out by each virtual learning team. Specifically,

- First, the subjects need to locate their team members from a list of team assignments given by the instructor. The subjects need to contact their team members by logging onto the meeting room of the course e-learning system and posting a message introducing himself or herself.
- Second, team members need to elect a team leader by themselves. This would be the first virtual team activity carried out by each team and compel the members to interact to make a decision.
- Third, team members need to work with each other on a case project over a period of six weeks. The project deliverable is a written team report due on a common date for all teams. The report has to include five sections in the following order: (1) introduction of the case assigned, (2) answers to structured questions about the case, (3) case analysis and findings, (4) description of a local e-business as a similar case to the instructor-assigned one, and (5) proposal of a new e-business concept, detailed analysis of the concept, and supporting materials. Guidelines for writing the first three sections are provided to the teams, but no guidelines are provided regarding the last two sections.

In order to assign cases of similar scope and difficulty, the instructor assigned all cases from the website http://digitalenterprise.org/cases/index.html. The assigned cases included America Online (AOL), Classmates, Ofoto, and Dell Computer. The cases were randomly assigned to virtual teams (one case per team), and supporting materials were also provided to the teams. Each assigned case included typically three questions. For example, in the Classmates case, the questions were how does Classmates make money, how do the membership tiers differ, and what explains the success of Classmates in converting members into paying subscribers? In the AOL case, the

questions were what factors help explain AOL's ascendancy to the largest online subscription service, what is the strategy behind AOL's merger with Time Warner, and why did the strategy fail?

In return for being a leader, the leader who is chosen by the group is not required to actually write the report. Instead, the leader's responsibility is to lead the team, advise members in writing the report, direct members to where relevant information can be found, and facilitate problem solving. The rest of the team members all need to contribute to writing the report.

The operational schedule is show in Table 1.

ICT media

To support the members' team-based learning activities and to facilitate their communication process, the instructor made available to students four types of ICT media: Microsoft Network (MSN) messenger, e-mail, online meeting room, and chat room. Each team and its members can use these four media in anyway as they see fit.

MSN messenger is a synchronous, many-to-many medium that allows the transfer of image, video, files, and messages. Users adopt pseudonyms to interact with others while retaining the option of remaining anonymous. MSN messenger turned out to be the most popular tool among subjects of this study. E-mail is technically an asynchronous medium that allows the exchange of longer messages. Users can also exchange various types of files using e-mail attachments.

Table 1. Operational schedule of the study

Week	Main Team Activities
1	• Instructor announces random team assignments and gives guidelines of preparing the report. • Team members elect their leaders.
2-6	• Teams work on their case projects.
6	• Team reports are due on the second to the last day of the week. • Subjects complete the questionnaire (leaders do not complete the questionnaire).

The meeting rooms were created using the course e-learning system, and each team was assigned a meeting room. The meeting rooms were private and were only accessible to members of the same team. To avoid being influenced by members of other teams, subjects could only view the discussion threads in their team's meeting room. Nevertheless, the instructor had access to all the meeting rooms. Subjects could use the meeting rooms to upload files and post messages to engage in discussions both asynchronously and synchronously.

Each team was also assigned a chat room in the course e-learning system. Unlike the meeting rooms, a team's chat room was open to everyone regardless of teams. Using the chat room, team members could compose messages for asynchronous communication. The chat room had a directory, allowing members to leave messages for each other, and had a voting function. In addition, the instructor could store video-based course materials in the chat room. In this study, the chat room was the least popular communication medium.

Measurement

This study examines the effects of different predictor variables on two variables of effectiveness of virtual learning teams: team performance and team satisfaction. To establish a research stream to prior literature in this area, we adopt previously-validated instruments so that cooperative research efforts can be promoted in the community (Hunter, Schmidt, & Jackson, 1983). Using validated instruments and agreed-upon constructs, researchers can also continue the research stream, conduct confirmatory, follow-up research across different settings and times, and support triangulation of results (Cook & Campbell, 1979). This way, the results can be consistently interpreted in light of the past literature in the area. In the long run, this approach can help to alleviate the confounding that is found in many research projects (Straub, 1989).

The investigation of the theoretical model requires the measurements of six variables. The construct of leadership roles is measured using the instrument of Denison, Hooijberg, and Quinn (1995). This measure consists of eight dimensions, each measuring one of the eight roles exhibited by a leader. Each dimension is assessed using two items. The "Broker" dimension was purposely omitted in the survey because it is not as applicable in the e-learning context and to keep the total number of questions on the survey to a manageable level.

Leadership effectiveness is measured using the instrument of Kayworth and Leidner (2002). This measure consists of five items. Using this instrument, team members assess three dimensions of their leaders' effectiveness: performance as a role model, managerial success, and overall managerial effectiveness. Team trust is measured using the instrument in the Jarvenpaa and Leidner (1999) study. This measure consists of eight items. Propensity to trust measure is adopted from the instrument of Jarvenpaa, Knoll, and Leidner (1998). This measure consists of four items. The two dependent variables of this study are team satisfaction and team performance. The dependent variable of team satisfaction measure is adopted from Tjosvold's (1988) instrument and has three items.

All items of the above-mentioned instruments are on a five-point Likert scale. Table 2 shows the Cronbach's alphas for all major variables. As can be seen in the table, all variables have good reliability with Cronbach's alpha higher than 0.7. Note that Cronbach's alpha is a measure of reliability, which ranges from 0 to 1 with values of 0.6 to 0.7 deemed the lower limit of acceptability (Hair et al., 1998, p. 88).

Table 2. Reliability of instruments used

Construct	Cronbach's alpha	Variables	# of Questions
Leadership Roles	0.73	Innovator	2
		Producer	2
		Director	2
		Collaborator	2
		Monitor	2
		Facilitator	2
		Mentor	2
Leadership Effectiveness	0.95	Leadership Effectiveness	5
Team Trust	0.91	Team	8
Team Satisfaction	0.90	Team Satisfaction	3
Individual Propensity to Trust	0.78	Individual Propensity to Trust	4

The dependent variable of team performance is measured by how the teams performed on their case reports. To increase reliability, the teaching assistant graded the case reports first, and the instructor graded the reports again and assigned final grades. Grades were given based on three criteria: rigor, creativity, and presentation. These criteria were communicated to students both verbally during the first F2F meeting and on the course e-learning system. The grades of the case reports were given in three ranks: high (greater than or equal to 85 points), middle (84-75 points), and low (equal to or less than 74 points).

Results

Descriptive statistics

The 164 students in the online course were asked to take the online survey. The leaders of the 14 virtual learning teams were asked not to take the survey. A total of 132 surveys were collected, giving a response rate of 80.5%. In the survey, the answer choices of the seventh question (which is one of the questions measuring team trust) were deliberately arranged in the opposite order as the other questions. This procedure is taken to screen out invalid responses as some students, when taking the survey, may have randomly clicked on answer choices. 19 responses were eliminated as a result. The number of valid returns is then 113 giving a final response rate of 68.9%. All 14 teams have response rates higher than 50%. Table 3 shows the profile of the 113 valid responses.

Table 3. Participants' profiles

Individual Traits	Category	The number of students	Percentage (%)
Gender	Male	45	39.82
	Female	68	60.18
Age	Below 20	50	44.25
	21-23	61	53.98
	24-26	1	0.88
	27-29	0	0.00
	Above 30	1	0.88
Online learning experiences (number of times)	0	69	61.06
	1	20	17.7
	2	14	12.39
	3	7	6.19
	4 and above	3	2.65
Virtual teaming experiences (number of times)	0	65	57.52
	1	24	21.24
	2	12	10.62
	3	4	3.54
	4 and above	8	7.08
E-mail usage	Never used before	0	0.00
	Used, not familiar	3	2.65
	Used, somewhat familiar	26	23.01
	Used, familiar	27	23.89
	Used, very familiar	57	50.44
Online chatting experience	Never used before	1	0.88
	Used, not familiar	2	1.77
	Used, somewhat familiar	15	13.27
	Used, familiar	31	27.43
	Used, very familiar	64	56.64
E-learning systems usage	Never used before	62	54.87
	Used, not familiar	14	12.39
	Used, somewhat familiar	10	8.85
	Used, familiar	18	15.93
	Used, very familiar	9	7.96

Table 4 shows the mean and standard deviation of investigated variables. The values are shown on a team-by-team basis (Team 1 through Team 14). In terms of the final dependent variables, the 14 case reports submitted have a mean of 76.4 and a standard deviation of 8.2, and team satisfaction has a mean of 3.86 and a standard deviation of 0.27. Team performances (grades of team reports) of six teams are greater than the overall mean, while team satisfactions of seven teams are greater than the overall mean of all subjects. All in all, five teams have team performances and team satisfactions that are both above the overall means.

Table 5 shows the inter-correlations among the variables. For the various leadership roles, the Pearson's correlation coefficients (*r-values*) range from 0.604 ($p < .05$) to 0.941 ($p < .01$) showing medium to high correlations among the various measured leadership roles. In addition, all seven leadership roles exhibit significant, positive relationships with leadership effectiveness as shown by *r-values* ranging from 0.621 ($p < .05$) to 0.913 ($p < .01$); also, all seven leadership roles exhibit significant, positive relationships with team trust as shown by *r-values* ranging from 0.584 ($p < .05$) to 0.761 ($p < .01$). In terms of the final dependent variables, there are significant and positive relationships between team performance and team trust (*r-value* = 0.773, $p < .01$), as well as between team satisfaction and team trust (*r-value* = 0.854, $p < .001$); however, there is no significant relationship between the two dependent variables of team performance and team satisfaction (*r-value* = 0.527, not significant).

Table 4. Mean and SD of variables as a function of teams

TEAMS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	All
# of response	7	8	11	6	6	10	5	7	8	9	9	11	9	7	113
Team performance	69	88	85	70	90	75	70	79	67	75	70	80	85	66	-
Mean Values															
Team performance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	76.4
Team satisfaction	3.48	4.13	3.79	4.28	4.17	3.50	3.80	4.14	3.46	3.93	3.7	4.06	3.89	3.76	3.86
Leadership effectiveness	3.54	4.05	4.15	3.87	4.07	3.22	4.16	4.09	3.35	4.16	3.67	3.75	4.22	3.40	3.83
Team trust	3.46	4.27	3.86	3.98	4.35	3.49	3.73	4.02	3.53	3.78	3.49	3.78	3.85	3.63	3.80
Propensity to trust	3.54	3.94	3.50	3.46	3.88	3.18	3.65	3.68	3.38	3.83	3.39	3.64	3.31	3.50	3.56
Leadership roles	3.41	3.87	3.77	3.83	3.95	3.21	3.97	3.88	3.47	4.03	3.16	3.61	3.93	3.22	3.67
Innovator	3.21	3.69	3.23	4.00	3.42	2.95	3.40	3.79	3.19	3.78	2.78	3.64	3.67	3.14	3.42
Producer	3.71	3.81	3.82	3.83	4.00	3.3	4.10	3.93	3.5	4.11	3.51	3.59	4.11	3.21	3.75
Director	3.36	4.19	3.91	4.17	4.42	3.35	4.20	4.07	3.88	4.28	3.56	3.68	4.22	3.29	3.90
Collaborator	3.64	3.88	3.82	3.92	4.17	3.35	4.20	3.93	3.44	4.11	3.39	3.73	4.00	3.43	3.79
Monitor	3.07	3.75	3.91	3.58	3.83	3.2	3.9	3.64	3.56	3.89	3.17	3.77	3.89	3.21	3.60
Facilitator	3.36	3.81	3.91	4.00	4.00	3.30	3.80	3.93	3.56	3.94	2.94	3.50	3.83	3.36	3.66
Mentor	3.50	3.94	3.77	3.33	3.83	3.00	4.20	3.86	3.19	4.11	2.83	3.36	3.78	2.93	3.55
Standard Deviations															
Team performance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.16
Team satisfaction	0.84	0.59	0.83	0.57	0.76	0.67	0.30	0.42	0.73	0.64	0.72	0.44	0.78	0.37	0.27
Leadership effectiveness	0.73	0.41	0.63	0.21	0.21	0.40	0.38	0.32	0.91	0.61	0.92	0.59	0.84	1.19	0.34
Team trust	0.63	0.50	0.42	0.34	0.73	0.49	0.21	0.30	0.68	0.44	0.39	0.47	0.71	0.33	0.28
Propensity to trust	0.30	0.44	0.39	0.43	0.49	0.39	0.42	0.37	0.78	0.6	0.38	0.39	0.80	0.43	0.22

Model testing

The regression analysis is adopted to test the influence of leadership roles on leadership effectiveness (H1) and the influence of leadership roles on team trust (H2). Note that the overall indicator of leadership roles is obtained by adding the scores of the seven measured leadership roles. Table 6 depicts the test results, which show that leadership roles have significant explanatory powers of variances in leadership effectiveness as well as in team trust. Specifically, the influence of leadership roles on leadership effectiveness is highly significant (β = .843, R^2 = .710, *F-value* = 29.387, p<.001). Thus, hypotheses H1 and H2 are supported.

Table 6. Regression of leadership effectiveness and team trust

DEP. VARIABLES / PREDICTORS	**LEADERSHIP EFFECTIVENESS**	**TEAM TRUST**
DIVERSIFIED LEADERSHIP ROLES	**.843*** R^2 = .710 F-VALUE = 29.387***	**.684** R^2 = .467 F-VALUE = 10.522**
LEADERSHIP EFFECTIVENESS	-	**.672** R^2 = .451 F-VALUE = 9.885**
PROPENSITY TO TRUST	-	**.704** R^2 = .495 F-VALUE = 11.784**

Note: * p<.05; ** p<.01; *** p<.001

Table 5. Pearson's correlation coefficients for all variables

Variables	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Leadership Effectiveness	3.83	.344																			
Leadership Roles	3.67	.312																			
2. Innovator	3.42	.353	.621*																		
3. Producer	3.75	.295	.913**	.648*																	
4. Director	3.90	.385	.831**	.690**	.867**																
5. Collaborator	3.79	.295	.896**	.709**	.941**	.874**															
6. Monitor	3.60	.309	.823**	.623*	.763**	.853**	.809**														
7. Facilitator	3.66	.326	.750**	.797**	.772**	.856**	.845**	.816**													
8. Mentor	3.55	.446	.854**	.604*	.901**	.781**	.909**	.789**	.789**												
9. Team Performance	76.36	8.16	.614*	.334	.474	.547*	.503	.616*	.523	.516											
10. Team Satisfaction	3.86	.269	.647*	.786**	.504	.663**	.649*	.559*	.660*	.430	.527										
11. Team Trust	3.80	.281	.672**	.639*	.559*	.760**	.691**	.641*	.761**	.584*	.773**	.854**									
12. Propensity to Trust	3.56	.222	.566*	.492	.508	.559*	.643*	.489	.517	.670**	.443	.602*	.704**								
13. Gender																					
14. Age	20.77	.291	-.268	.116	-.077	-.225	-.094	-.331	-.089	-.084	-.070	-.047	-.077	.154	-.278						
15. OAL experience	1.781	.403	.048	.183	.039	.049	.119	-.139	.060	-.010	-.583*	.190	-.041	.076	.296	-.321					
16. Virtual team experience	1.852	.421	-.287	.037	-.327	-.134	-.136	-.180	-.034	-.268	-.174	.117	.087	-.153	-.107	-.426	.456				
17. E-mail experience	4.232	.306	-.189	-.006	-.177	.145	-.203	-.086	-.075	-.216	.003	.072	.213	.133	.527	.094	.025	.034			
18. Messenger experience	4.394	.263	-.017	.211	-.052	.259	-.024	.030	.075	.008	-.081	.227	.296	.321	.510	-.251	.412	.369	.774**		
19. E-learning experience	2.130	.386	-.140	.249	-.083	.092	.039	.075	.265	-.076	-.474	.143	-0.007	.034	.251	.124	.494	.066	.225	.177	.810**

Note 1 : N=14 ; * p < .05 ; ** p < .01

Table 6 also depicts the result of testing the influence of leadership effectiveness on team trust (H3) as well as the influence of propensity to trust on team trust (H6). The tests show that both leadership effectiveness and propensity to trust have significant explanatory powers of variance in team trust, thus hypotheses H3 and H6 supported.

Table 7 shows the result of testing the influence of team trust on team performance (H4a) as well as the influence of team trust on team satisfaction (H4b). The tests show that team trust does have significant explanatory powers of variances in both team performance and team satisfaction, especially in team satisfaction. The influence of team trust on team satisfaction is highly significant (β = .854, R^2 = .729, *F-value* = 32.294, p<.001). Thus, hypotheses H4a and H4b are supported.

Table 7. Regression of team performance and team satisfaction

DEP. VARIABLES / PREDICTOR	TEAM PERFORMANCE	TEAM SATISFACTION
TEAM TRUST	.773** R^2 = .597 F-VALUE = 17.779**	.854*** R^2 = .729 F-VALUE = 32.294***

Note: * p<.05; ** p<.01; *** p<.001

To test whether or not team trust mediates the relationship between leadership effectiveness and team performance (H5a) and between leadership effectiveness and team satisfaction (H5b), we employ the conditions stated by Baron and Kenny (1986) and use stepwise regression. In particular, the following four conditions have to be satisfied to support the existence of a mediating variable:

- Condition 1: Leadership effectiveness exerts significant influence on team trust.
- Condition 2: Team trust exerts significant influence on team effectiveness.
- Condition 3: Leadership effectiveness exerts significant influence on team effectiveness.
- Condition 4: Leadership effectiveness exerts a reduction of or insignificance of influence on team effectiveness with the inclusion of team trust.

In other words, team trust is a mediating variable if its inclusion results in a lowered or insignificant relationship between leadership effectiveness and team effectiveness. Note that Conditions 1 and 2 are already satisfied because previous analyses have shown that H3, H4a, and H4b are supported.

To examine Conditions 3 and 4, we use stepwise regression. Table 8 shows the results of stepwise regression. As can be seen in the table, Condition 3 is satisfied because leadership effectiveness exerts significant influence on both team performance and team satisfaction. Condition 4 is also satisfied because once we include the variable team trust, the relationships between leadership effectiveness and team performance and between leadership effectiveness and team satisfaction are no longer significant. Therefore, H5a and H5b are supported.

Table 9 shows the summary of hypothesis testing.

Table 8. Stepwise regression

DEP. VARIABLES / PREDICTORS	TEAM PERFORMANCE	TEAM SATISFACTION
LEADERSHIP EFFECTIVENESS (WITHOUT TEAM TRUST)	.614* R^2 = .377 F-VALUE = 7.254*	.647* R^2 = .418 F-VALUE = 8.625*
LEADERSHIP EFFECTIVENESS (WITH TEAM TRUST)	.172	.133

Note: * p<.05; ** p<.01; *** p<.001

Table 9. Summary of hypothesis testing

Hypothesis	Results		
	Supported?	R^2	F-value
H1: A leader has higher leadership effectiveness when exhibiting diversified leadership roles in a virtual team.	Yes	0.71	29.387***
H2: Trust among team members can be improved when a leader exhibits diversified leadership roles in a virtual team.	Yes	0.467	10.522**
H3: Leadership effectiveness established by a leader can improve trust among team members in a virtual team.	Yes	0.451	9.885**
H4a: Higher trust among team members can lead to higher team performance of team members in a virtual team.	Yes	0.597	17.779**
H4b: Higher trust among team members can lead to higher team satisfaction of team members in a virtual team.	Yes	0.729	32.294***
H5a: Team trust mediates the relationship between leadership effectiveness and team performance of team members in a virtual team.	Yes	See Table 8	
H5b: Team trust mediates the relationship between leadership effectiveness and team satisfaction of team members in a virtual team.	Yes	See Table 8	
H6: The higher propensity of team members to trust each other, the higher trust among team members in a virtual team.	Yes	0.495	11.784**

Note: * p<.05; ** p<.01; *** p<.001

Discussions

Leadership effectiveness

Leadership effectiveness is one of three dependent variables investigated by this study. This study shows that a higher degree of diversified roles exhibited by a leader can help improve leadership effectiveness (H1). Although this result is consistent with prior studies on teams in organizations (Mintzberg, 1973; Jessup, 1990; Denison, Hooijberg, & Quinn, 1995), our study confirms the existence of the same relationship in a virtual collaborative learning environment. Positive relationships exist for all seven leadership roles measured, demonstrating that it is important for a leader in a virtual environment to exhibit diversified leadership roles as needs arise.

In particular, the producer role has the highest correlation ($\beta = 0.913$, $p<.01$). Denison, Hooijberg, and Quinn (1995) define the producer role as a "task-oriented, work-focused role. The producer seeks closure, and motivates those behaviors that will result in the completion of the group's task." (p. 527) On the other hand, the innovator role has the lowest correlation ($\beta = 0.621$, $p<.05$); this role is defined as one who is "creative and envisions, encourages, and facilitates change" (Denison, Hooijberg, & Quinn, 1995, p. 527). These results show that although the innovator role is important, it is less important in an environment where ideas have to be quickly generated and efforts have to be spent actually completing the team project. As such, the producer role is treated as the most important as the virtual team is under a tight deadline to produce and hand in the project assignment on time.

Additionally, disagreements and conflicts often occur in latter stages of a virtual learning period when deadline nears. In this situation, a leader of a virtual learning team needs to shift from innovator-mentor roles to producer-director roles, at the same time attempting to harmonize any strained relationships and to mitigate conflicts in latter stages.

Team trust

This study found that a positive relationship exists between leadership roles and team trust (H2). This is a novel hypothesis proposed by this study, and this research demonstrates that diversified leadership roles exhibited by a leader are important in contributing to team trust. Teammates effectively create trust as a psychological contract by

expecting reciprocal obligations between each other (Rousseau, 2001). Although all roles measured exhibit positive, significant relationships with team trust, it is interesting to note that in this case the producer role is the role that has the lowest correlation ($\beta = 0.559$, $p<.05$). This is an opposite result as contrasted with the relationship between leadership roles and leadership effectiveness (where the producer role has the highest correlation). This result offers a key insight into the tradeoff between leadership effectiveness and team trust. From the perspective of diversified leadership roles, a dominant producer role can contribute to higher leadership effectiveness, but its effect on team trust is the weakest out of the roles measured.

At the aggregate level, the relationship between leadership roles and team trust ($\beta = 0.684$, $p <.01$) is less pronounced and less significant than the relationship between leadership roles and leadership effectiveness ($\beta = 0.843$, $p <.001$). This difference may be due to the structure of the research study. It is admittedly difficult to build trust with people whom one never met before the course, in an environment where the predominant communication modalities are e-mails, chat rooms, and messengers, and over a period of only six weeks. These factors may have structurally dampens the positive effects of leadership roles exerted on creating team trust.

There is also a positive relationship between leadership effectiveness and team trust (H3). Although prior research (i.e., Jarvenpaa, Knoll, & Leidner, 1998; Jarvenpaa & Leidner, 1999; Pauleen, 2003) have in general hinted at the existence of an association between leadership effectiveness and team trust, none have explicitly tested such a relationship using either case or survey. The contribution of this study is the confirmation of the same relationship in the virtual team context using the survey methodology. This relationship is especially important in virtual teams where communication is enabled by ICT where ICT-enabled media typically have low media richness.

In addition, there is a positive relationship between propensity to trust and team trust (H6). This positive relationship is supported by Jarvenpaa, Knoll, and Leidner (1998). Team trust is an important determinant of overall team effectiveness, yet team trust typically is not developed before the formation of the team. Thus, propensity to trust can serve as a "leading indicator." Before the formation of a team, this indicator can be used to assess candidate members' propensities to trust, and the information can be used to determine whether or not the members, if put on the same team, are likely to trust one another. High team trust in the resulting team then should contribute to overall team effectiveness. Because personality traits can influence one's disposition or propensity to trust others (Mayer, Davis, & Schoorman, 1995), the evidence gathered of the relationship is especially strong as we controlled for this by randomly assigning students to virtual learning teams without regard to their social backgrounds.

Team effectiveness

Team effectiveness is the dependent variable examined in this study. Team effectiveness consists of two proxies—team performance and team satisfaction—and team trust is found to be positively correlated to both team performance and team satisfaction (H4a and H4b). Previous studies have confirmed the critical role of trust in group performance in different types of F2F teams, and our study extends those results to virtual learning teams. Although past literatures on virtual teams have suggested the contribution of team trust on team effectiveness, they are mostly case studies (e.g., Lipnack & Stamps, 1997; Jarvenpaa & Leidner, 1999). This study confirms the same relationship using the survey methodology. In addition, the positive results shown by this study confirm the importance of trust in creating not only successful outcomes (i.e., team performance) but also the process taken to achieve those outcomes (i.e., team satisfaction). These results are robust because the two dependent variables (i.e., team performance and team satisfaction) exhibit insignificant correlations with each other, demonstrating that the effects exhibited by team trust are separate and noteworthy.

Moreover, this study demonstrates that team trust plays a mediating role between leadership effectiveness and team performance (H5a), as well as between leadership effectiveness and team satisfaction (H5b). This result is a novel contribution that has a sound theoretical underpinning—if team members do not trust each other, then regardless how effective is the leader, team performance and satisfaction would suffer. In this regard, team trust is perhaps more important in a virtual environment because both media rich theory (Daft & Lengel, 1986) and social presence theory (Short, Williams, & Christie, 1976) logically lead to the suggestion that ICT media may suppress communication cues that people use to convey trust and attention (Jarvenpaa & Leidner, 1999). Thus in order for a leader to be *effective* in leading the team to success, team trust has to be promoted and cultivated. For future research, it may be interesting to investigate if the mediating effect played by team trust is more pronounced in a virtual learning

environment than in a F2F environment. Because ICT media are not as rich as F2F, in a virtual setting team trust may play a more prominent role in mediating the relationship between leadership effectiveness and team effectiveness.

Limitations

There are some important limitations of this research study. First, the dynamics of team performance are highly task-dependent. The deliverable for which the teams are responsible is the case report, and the environment in which the teams operate is an online undergraduate course. Thus the results of this study cannot be generalized to other types of tasks and other contexts. Second, although team performance (i.e., grade on the case report) is assessed first by the teaching assistant then by the instructor, no effort is made to conceal the identity of the students who wrote the reports. Thus the grading of the reports may be subject to biases. Third, participants consist mostly of university students who have had experience using online tools. Because of their similar backgrounds, it is assumed that prior knowledge is similar among all participants. Nevertheless, using subjects' background data to statistically control the results can produce a stronger argument for the results. Lastly, the study uses a cross-sectional design and does not use longitudinal or controlled experimental design. Thus causation is claimed not based on evidence produced by the study but based on theoretical arguments.

Implications

Despite the limitations mentioned above, there are some practical implications as a result of this study. Given that this research has demonstrated the importance of leadership roles, one may want to use a questionnaire to assess candidate leaders' leadership roles and traits before deciding on a virtual team leader. Installing a leader that possesses diversified leadership roles increases the likelihood of team success. In addition, the findings demonstrate the importance of leadership effectiveness in improving team effectiveness in a virtual learning environment. Therefore, to ensure high team performance and satisfaction, one may consider installing a leader that has been proven effective in previous engagements (via other instructors' feedback or other evidence). However, when a leader is elected by team members, it may not be possible to prescreen using history or questionnaire. In this case, it would be beneficial to provide training and workshops for the elected leader to improve his or her effectiveness and ability to perform diversified roles.

Moreover, this study has shown that team trust is not only a predictor of both team performance and team satisfaction, but also a mediating variable that affects the relationship between leadership effectiveness and team effectiveness. Thus trust is a very important variable to the success of a virtual learning team. Yet, when a virtual team first comes together, team trust can only form during the course of team activities and processes. But to the extent possible, there are benefits to including as many members as possible who have previously worked together on successful projects. This way team trust is likely to be higher to start with. Additionally, given that team trust plays such a crucial role in the overall team success, it may make sense to include in a team as many members as possible who have high propensity to trust (selected using a pretest questionnaire).

Conclusion

Many higher-education institutions around the world are increasingly relying on the online learning model to deliver education to students who otherwise cannot or would not physically attend. This study examines the effect of different predictor variables on two variables of effectiveness of virtual learning teams: team performance and team satisfaction. Specifically, the diversified roles played by learning team leaders and leadership effectiveness, as well as team trust and propensity to trust, are examined. This study integrates the theories of both leadership and virtual teams in the context of e-learning, and through a field study of an undergraduate MIS online course collects data to investigate the existence of significant paths among the variables.

The results of this study show that, in a virtual learning environment, diversified leadership roles contribute to leadership effectiveness; diversified leadership roles, leadership effectiveness, and propensity to trust all positively influence team trust, which in turn contributes to two indicators of team effectiveness—performance and satisfaction.

In addition, team trust is found to be a significant variable that mediates the effect transmitted from leadership effectiveness to team performance, as well as from leadership effectiveness to team satisfaction. Educators can gain insight from the proposed theoretical model and field study results. To improve effectiveness of online learning teams, educators can consider assigning effective virtual team leaders and promoting trust among team members.

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