Team Effectiveness in Virtual Environments: An Ecological Approach
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ABSTRACT

This chapter attempts to address the need for more research on virtual team effectiveness and outlines an ecological theoretical framework that is applicable to virtual learning environments (VLE). Prior empirical studies on virtual team effectiveness used frameworks of traditional team effectiveness and mainly followed Hackman's normative model (input-process-output). We propose an ecological approach for virtual team effectiveness that accounts for team boundaries management, technology use, and external environment in VLE, properties which were previously either non-existent or contextual. The ecological framework suggests that three components, external environment, internal environment, and boundary management, reciprocally interact with effectiveness. The significance of the proposed framework is a holistic perspective that takes into account the complexity of the external and internal environment of the team. Furthermore, we address the needs for new pedagogical approaches in VLE.

INTRODUCTION
As a result of globalization and advances in information and communication technologies, the increased use of virtual teams (VT) in both education and business has become prominent (Weiss, Nolan, & Trifonas, in press). VT are "group[s] of people who work interdependently with a shared purpose across space, time, and organization boundaries using technology" (Lipnack & Stamps, 2000, p. 18). The need for more theoretical and empirical research on virtual team effectiveness (VTE) (e.g. DeSanctis & Poole, 1997; Furst, Blackburn & Rosen, 1999) attracted several empirical studies (e.g. Vickery, Clark & Carlson, 1999; Anderson, 2000; Lurey & Rainghani, 2001). Most of these studies on VTE - were conducted under the systems approach using Hackman's normative model (input-process-output) for traditional team effectiveness (Hackman & Oldham, 1980).

Previous studies of VTE emerged from the body of knowledge on traditional (face-to-face) teams (Hackman & Oldaham, 1980; Shea & Guzzo, 1987; Pearce & Ravlin, 1987; Sundstrom, DeMuese & Futrell, 1990; Cohen & Bailey, 1997) and from theoretical perspectives on the interplay between information technology (IT) and organizations (Orlikowski, 1992; DeSanctis & Poole, 1994; Kling, McKim, & King, 2003). In this chapter we will capture the complexity of work groups and IT under a framework that manifests environmental aspects (social, cultural, organizational, and technological) and propose an ecological approach that would be relevant to teaching and learning with virtual teams. This theoretical framework is delineated from synthesizing, adopting, and modifying theories from other fields and levels of analysis. Specifically, we are influenced by several ecological theories, such as ecological psychology at the individual level (Barker, 1968; Bronfenbrenner, 1979; Wicker, 1979) and group level (Sundstrom, et al., 1990), as well as theories on IT and organizations, such as media richness theory (Lengel & Daft, 1988), and a social action framework (Ngwenyama, & Lyytinen, 1997).

While many universities offer education via online environments (Dutton & Loader, 2002), it is becoming crucial to understand VTE for teaching and learning. Some MBA programs (e.g., Kelly Direct Online Program at Indiana University, Ohio University Without Boundaries) organize their online courses around team-based environments, and students are required to work in VT. In order to work effectively in VT, students and especially instructors need to become aware of all the components that influence VTE. This chapter proposes ecological approach to VTE and indicates its implications to online learning.

The main reason for selecting an ecological framework for VTE is because it stresses the critical role of the environment through a reciprocal interdependency between internal processes and the external environment. It was previously suggested that internal and external environments influence VTE (Lurey & Raisinghani, 2001), and that an ecological approach helps us understand VTs.

Before we outline the ecological framework components, several assumptions should be stressed (Wicker, 1979):

1. A VT organism cannot be considered to exist or act in isolation. Every VT organism is linked with other organisms in a complex network of relationships.

2. All VT organisms are affected by forces inside themselves, such as leadership, team norms, technology use, and process losses (e.g. conflict management), as well as by external forces of other organisms, such as team competitors, the instructors, and the VLE technology.

3. VTs adapt and act in a way that achieves harmonious working relationships with their environment, distinguishing between features that are appropriate for their needs and those that are not.

VIRTUAL TEAM EFFECTIVENESS

The research on virtual teams is in its infancy and has a variety of foci. Researchers are making efforts to determine how virtuality impacts team effectiveness (Dube & Pare, 2004; Furst, Blackburn, & Rosen, 1999; Martins, Gilson & Maynard, 2004; Pauleen, 2003). Furst, Blackburn, and Rosen (1999) suggest that the lack of research on VTE is partially a result of the newness of VTs and partially a result of the underlying assumption that the existing knowledge of traditional team effectiveness is applicable in the virtual environment. They proposed a research agenda on VTE based on Hackman's normative model (Furst, Blackburn, & Rosen, 1999). Likewise, Martins, Gilson, and Maynard (2004) recently reviewed the body of knowledge on virtual teams, and also

followed Hackman's normative model for team effectiveness. They suggest future research directions that focus on virtual teams.

A recent claim was made that a virtual team "can be more productive if they stay separated and do all their collaborating virtually." (Majchrzak, Malhotra, Stamps, Lipnack, 2004, p.131) A few studies have made an effort to compare performance of traditional and virtual teams and to identify factors that are involved in virtual team effectiveness (Dennis & Wixon, 2002; May & Carter, 2001; McDonough et al., 2001; Vickery, Clark & Carlson, 1999). May and Carter (2001) found that team effectiveness and efficiency are higher for virtual teams compared to traditional teams but that the level of satisfaction is lower. Dennis & Wixon (2002) in their meta-analysis of group support systems use examined 61 articles and compared the performance of face-to-face (FTF) vs. distributed virtual teams. They reported that "FTF use of GSS [group support systems] improves decision quality and the number of ideas relative to the control groups working without GSS, however, FTF GSS use requires more time and lower process satisfaction. In contrast, distributed teams made worse decisions than the control groups working without GSS." (p.245) Decision quality is lower for virtual teams, but the number of ideas generated is not different.

Greater management challenges are associated with lower performance for the three types of teams in this study of new product development teams: collocated, global, and virtual. According to a survey of 103 individuals, conducted by McDonough et al. (2001), global team performance is lower than the performance of virtual or collocated teams. The global teams also face greater behavioral and project management challenges than the virtual teams. The results suggest that project management challenges are more a function of geographical distance than of cultural or language differences. However, no relationship is evident between behavioral challenges and team performance.

Another study involved 273 individuals from 84 teams and focused on performance (Vickery, Clark & Carlson, 1999). The researchers found that stronger virtual positions perform better in complex rather than simple task situations. Furthermore, they suggest that the organizational structure of the parent organization of team members affects the allegiance structure and the control climate of the virtual team; this, in turn, affects the strength of the virtual position.

A survey, completed by 67 participants from 12 teams in 8 companies, involved a questionnaire based on a framework for virtual team effectiveness developed by Lurey and Raisinghani (2001). The framework includes three main factors that are expected to have a direct effect on team effectiveness. These factors are: internal group dynamics (job characteristics, selection procedure, team member relations, team process, internal team leadership); external support mechanisms (education system, reward system; executive leadership style, tools and technologies, communication patterns); and design process. The outcome measures of effectiveness were performance and satisfaction. Correlations among the predictor variables and performance and satisfaction were significant at the 0.01 for all variables except for tools and technology, which was significant at 0.05.

ECOLOGICAL FRAMEWORK

The proposed ecological framework consists of three components that are critical to VTE: external environment, internal environment, and boundaries. Compared to Hackman's normative model (Hackman & Oldham, 1980), our framework is more holistic and emphasizes continuing dynamic process, disregarding chronological sequence. The components are reciprocal and interdependent among themselves (Figure 1).

Insert Figure 1 approximately here.

External Environment

The external environment is a critical component for VTE. Following Bronfenbrenner (1979), we suggest that VT behavior is embedded in a setting that could be categorized into four levels: microsystem, mesosystem, exosystem, macrosystem (Figure 2).

Insert Figure 2 approximately here.

The microsystem is the immediate setting in which the team experiences its own activities, roles, and interdependency, within a specific setting (e.g., the VT physical and digital space, their role setting, assignments, and participation requirements). In virtual learning environments (VLE), it is equivalent to pedagogy that instructors incorporate. The mesosystem refers to the relationships between two or more of the settings in which the team participates. The network of teams (virtual and collocated) and organizations that team members act within are a system of microsystems making up a mesosystem. In VLE, it refers to the course. The exosystem refers to one or more settings that the team is not involved in as an active participant, but in which events occur that affect, or are affected by, what happens in the setting of the VT (for example, in this case, curriculum). The macrosystem refers to consistencies among the lower level systems, at the level of culture or subculture, such as department, school, and university. The macrosystem also refers to the general environment—the legal, political, social and cultural environments.

Since VT behavior and its effectiveness are embedded within the specific setting of the team's microsystem, more than any of the other systems, we further elaborate on the components of this level which are important for team effectiveness (Hackman & Oldham, 1980; Pearce & Ravlin, 1987; Shea & Guzzo, 1987; Sundstrom et al., 1990). In this chapter, among the four levels of environments, we mainly elaborate on the microsystem because it has an immediate impact on the VTE. VT behavior and its effectiveness are embedded within specific the setting of the team's microsystem. This context is a critical component of team effectiveness (Hackman & Oldham, 1980; Pearce & Ravlin, 1987; Shea & Guzzo, 1987; Sundstrom et al., 1990) and is composed of seven dimensions. These seven dimensions are derived from factors that were proposed by other frameworks for traditional team effectiveness and in particular from the Sundstrom et al. (1987) ecological approach to traditional teams. In addition, Barker's (1968) ecological approach influenced us to include additional factors, which are relevant to virtual teams, and have not been included in the Sundstrom et al. (1987) framework. The following paragraphs describe these seven dimensions. Geographical locus (Barker, 1968) is the physical setting of the VT. Space is a critical component of identity and boundary maintenance (Sundstrom et al., 1990). The VT's physical space is used only for temporary collocation (e.g., during face-to-face meetings) or not used at all for teams who never meet. However, the VT uses a digital space to substitute for the lack of physical space. Any courseware (e.g., Blackboard and WebCT) has a shared digital space for students to share files and have team online discussions. Instructors who teach online courses should take advantage of such functions available through courseware.

Temporal locus and duration (Barker, 1968) are the team life-cycle and the pace and length of member interactions within the team. VT development and life cycle are temporal (Vickery, Clark & Carlson, 1999) and members share work time based on the shared digital space. Although online courses are also organized temporally, some online programs structure the curriculum so that student cohorts stay together throughout the program.

Cultural contexts (Shea & Guzzo, 1987; Sundstrom at el, 1990) are the cultures surrounding the team at three levels: professional, organizational, and national culture (Schein, 1992; Hofstede, 1991). For example, the culture would affect team norm development, communication, decision making, and performance evaluation (Furst, Blackburn & Rosen, 1999). As online learning offers flexibility and convenience, many working professionals enroll in online courses. Consequently the students in online courses tend to be non-traditional with diverse backgrounds. Moreover, online

courses offered by American universities attract students from all over the world. The instructors and students in VLE need to be sensitive to cultural diversity.

Technological context refers to "task technology", which is the technology used for performing the task (Hackman & Oldham, 1980, Shea and Guzzo, 1987; Sundstrom et al., 1990), to media channels and to telecommunication infrastructure. The infrastructure should be taken into consideration in terms of team effectiveness. It is evident that administrators of distance education programs should pay attention to which subject-matters can be properly taught in VTE. For example, highly technical content is rather difficult to teach and learn in online environments (e.g., Hara & Kling, 2000) because students need to deal with both technologies as means as well as subject-matter. Although MBA programs adopt their traditional courses to online learning, in many ways, these MBA students have already experienced working in virtual teams. Additionally, VT might have to deal with diverse configurations and regulations which exist in different places (e.g., several organizations, several countries).

Participation forces (Barker, 1968) are the environmental factors that motivate team members to be part of the VT. The rationale for participation in a VT could be intrinsic, for example, to volunteer (e.g., open source community) or to work under a specific organizational reward system, which involves extrinsic motivation (Hackman & Oldham, 1980; Pearce & Ravlin, 1987; Shea & Guzzo, 1987; Sundstrom et al., 1990. Students in VLE seldom have the choice of participation in teams due to the fact that this is part of the course requirements. However, students vary in their motivation for participation. Participation forces are relevant to retention rates in online learning. Studies (e.g., Irizarry, 2002) show that students who are self-motivated and have high self-efficacy tend to stay with online courses. In addition, student achievement level, ability to conceptualize, interest in the topic, and other factors which are relevant to team success in the traditional face-to-face learning environment, define their participation and contribution to the virtual team. Finally, the weight of the grade assigned by the instructor to the virtual team assignment in any particular course (reward) will define the level of participation of student in the VLE.

Autonomy and control system are the degree of independence a VT has to conduct its task (Shea & Guzzo, 1987; Pearce & Ravlin, 1987; Sundstrom et al., 1990). For example, high team autonomy means that the team could make decisions in regard to members' roles, without approval from instructors. Instructors make decisions about how much autonomy students have in VLE. Team development support is the training and consultation the instructors and higher education institutions provide to support teamwork (Hackman & Oldham, 1980; Pearce & Ravlin, 1987; Sundstrom et al., 1990) and performance evaluation (Sundstrom et al., 1990). Studies that focused attention on VT facilitation (Montoya-Weiss, Massey, & Song 2001; Pauleen & Yoong, 2001; Warkentin& Beranek, 1999) stressed the importance of team building training. Institutions providing online courses should pay particular attention to this kind of training.

To summarize, in this section, we described four levels of VT's external environment: microsystem, mesosytem, exosystem, and macrosystem, in which the VTs are embedded. A specific elaboration and emphasis of the components of microsystems was further described because these components are more critical success factors for VTs. Among these factors are geographical locus; temporal locus and duration; cultural context; technological infrastructure; organizational support mechanism; autonomy and control mechanism; and forces of participation.

Boundaries Management

The second component of the ecological framework is boundary management. The ecological approach emphasizes the issue of creating and maintaining boundaries (Sundstrom et al., 1990). Group boundaries (physical and psychological) determine who is in the group (Alderfer, 1977). A VT is defined as a team by the boundaries that are formed and maintained over time. These boundaries become critical components of VT viability. Experimental studies of traditional teams

and VTs do not stress this aspect (Sundstrom et al., 1990) because team boundaries are pre-defined, and that is the case for many VLE. Studies on real VTs in an organizational setting suggest that boundary creation and maintenance are critical (Pawar & Sharifi, 1997; Robey, Khoo & Powers, 2000; May & Carter, 2001; Sole & Edmondson, 2001). Boundary management differentiates the team from its environment, so that it will have its unique identity. At the same time, boundary management integrates the team with its environment to avoid isolation. Three components of boundary management will be further described: differentiation, integration (Sundstrom et al., 1990), and the creation of team identity.

Differentiation refers to the specialization, interdependence, and autonomy of the team. VTE depends on the ability of the team to differentiate its members from others, in order to conduct meetings and share information (Sundstrom et al., 1990). Both for traditional and virtual teams the task and team resources (e.g., members, time, and space – even temporarily physical co-location) are critical for differentiation. However, in VT, the physical limitations make this process more complex, and the differentiation is based also on the shared digital space of the team.

Integration refers to the ties of the VT with its immediate organizational environment and to other teams. Integration refers to the team's relationships with peers and instructors, which are not part of the VT. To facilitate the process of integration, many online programs offer face-to-face orientations as well as summer sessions. Research (see e.g., Barbian, 2002) also suggests that blended online learning (i.e., combining face-to-face and virtual learning) produces best learning outcomes.

Creation of team identity is crucial to the performance of VTs. Physical territories reinforce group boundaries and identities (Sundstram et al., 1990). The lack of physical territories was attributed to the deindividuation process of computer-mediated groups (Lea & Spears, 1991). In order to overcome this drawback, VT members rely on shared electronic space for the creation of team identity. This electronic shared space is devoted only to the members of the team and enables them to share experience.

In summary, VT creates and maintains permeable "virtual boundaries," which are not defined by functional or geographical aspects, but are instead based on a temporal task or project. The shared digital space creates and maintains boundaries. This shared digital space and the temporal physical collocation of team members help the team to mange its boundaries and identities. Differentiation and integration should be balanced. For example, too much differentiation inhibits integration, and vice versa.

Internal Environment

The third component in the proposed ecological framework is the internal environment. Within the internal environment, the following factors for team effectiveness have been discussed in the literature as process or contextual variables: team composition and design (Hackman & Oldham, 1980; Pearce & Ravlin, 1987), communication (Javenpaa & Liedner, 1999; Pearce & Ravlin, 1987), team development (Sundstrom, et al., 1990), conflict management (Montoya-Weiss et al., 2001), leadership (Lurey & Raisinghani, 2001), norms (Sundstrom, et al., 1990), commitment (Hackman & Oldham, 1980; Pearce & Ravlin, 1987), and trust (Javenpaa & Liedner, 1999). We suggest two additional components that influence VTE: technology use (Ngwenyama, & Lyytinen, 1997; Lengel & Daft, 1988) and internal boundary spanning (Wenger, 1998). Unlike other authors (Sundstrom et al., 1990), we propose to differentiate task technology and information and communication technology (ICT) and consider technology use not only as a contextual factor, but also as an internal factor, specifically by using a social action framework (Ngwenyama, & Lyytinen, 1997).

The technology that the VT uses to achieve its tasks should support team social actions. The focus of the social action framework for analyzing groupware (Ngwenyama & Lyytinen, 1997) is the use of IT for communication and creation/use of knowledge among VT members. They suggest the

following four social action categories in groupware: instrumental, communicative, discursive, and strategic. Instrumental action focuses on end products by controlling, manipulating, and transforming physical artifacts, such as providing concrete explanations for assignments, distributing readings, and making links to library databases. Communicative action supports creating and maintaining shared understanding among members and is facilitated by computer-mediated communication (CMC). Discursive action specifies and evaluates goals and objectives as well as achieving a consensus on shared values and norms, for example, through the use of a voting system or anonymous contributions to course online discussion forums. Strategic action influences the group behavior to achieve common goals, such as access restrictions to the shared digital space. During the process of work, each of these social actions uses technology, appropriating different functions of courseware.

In addition, the other internal component critical to VTE is internal boundary spanning. We suggest that not only external boundary management, in the traditional sense, but also internal boundary spanning should be discussed as part of the VTE ecological framework. Heterogeneous VTs incorporate multiple boundaries. Individuals from different geographical locations, organizations, nations, and professions traditionally have boundaries that differentiate each group from others. Watson-Manheim, Crowston, and Chudoba (2002) defined virtual work as work that spans discontinuities of temporal work location, geographic work location, group membership, organizational affiliation, and cultural background. Therefore, in VTs, these discontinuities create a need for the internal process of boundary spanning, as students in VLE come from diverse backgrounds. In a heterogeneous VT, these boundaries are integrated internally within the team through the process of boundary spanning.

Several types of boundary spanning are embedded in heterogeneous VT (Lipnack & Stamps, 2000). The first type of boundary spanning occurs on geographical dispersion, where team members do not share the same physical space. The second type of boundary spanning occurs based on cross-functional membership of professionals using several languages, backgrounds, and cultures. The third is of organizational affiliation manifesting inter-organizational relationships, organizational cultures, and power interdependencies of the team members' parent organization. This dimension is relevant only to the rare examples of collaborative courses among several institutions. The educational culture, rules and procedures, vary among institutions. The fourth is based on international diversity of languages, cultures, and religions. The final type of boundary spanning is time zones of team members who are working in different parts of the globe. Not all types of boundary spanning, except for geographical dispersion, may occur in individual VTs. The boundary spanning process occurs either through a broker or boundary object (Wenger, 1998). Brokers are team members who introduce new knowledge and practices into the VT while boundary objects are artifacts within a VT digital space (e.g., new literature).

The next sections will describe other components of our ecological framework internal environment as emerged from previous studies on virtual teams. This involves an outline of the findings of studies that focus on team processes, such as trust, leadership, commitment, conflict management, and communication.

Communication among team members is one of the process predictors of team effectiveness. Effective communication is attributed to effective teams. Communication impacts satisfaction and performance, helps overcome process losses, and strengthens process gains. Communication among GVT members is more complex due to the fact that it is mediated by computers and involves cross-cultural communication. Therefore, effective communication is even more critical for success in the virtual setting. For that reason, several studies focus attention on the virtual team communication process (e.g., Jarvenpaa & Leidner, 1999; Maznevski & Choduba, 2000; Pauleen & Yoong, 2001a; Pawar & Sharifi, 1997; Robey, Khoo & Powers, 2000; Warkentine, Sayeed, & Hightower,1997).

Communication among virtual team members has been examined within virtual teams and also in comparison with collocated teams. Scholars stress that effective GVTs fit their

communication patterns to the task and keep a strict pace of face-to-face meetings (Pawar & Sharifi, 1997; Maznevski & Choduba, 2000). In addition, they suggest that temporal collocation and face-to-face meetings among virtual team members increase communication effectiveness and information sharing (Sole & Edmondson, 2002). Pauleen and Yoong (2001a) found that some electronic communication channels are more effective than others in building online relationships. In their study, email was the basic channel for communication but was used primarily for information sharing and not for relationship building, which was primarily supported by telephone exchange. The participants (facilitators of virtual teams) in this study used chat (ICQ) to set up opportunities for informal, spontaneous communication between facilitators and team members. As several scholars stress, however, informal communication is minimal among virtual team members (Pawar & Sharifi, 1997; Carletta et al., 2000; Robey, Khoo & Powers, 2000). According to Carletta et al. (2000), if meetings are kept small and informal, interactivity and sociability improve, scheduling delays decrease, and opportunities for members of lower status to raise their own concerns are created. In research by Massey et al. (2001), significant differences occurred in the perception of task technology fit between virtual team members from the US, Asia, and Europe. Team members perceived communication, particularly media choice, as a strategic activity that had to be planned (Suchan & Hayzak, 2001).

Categorization of communication incidents are performed in several studies, using various categorization schemas. Maznevski and Choduba (2000) distinguish among communication incidents based on objectives: information gathering, problem solving, idea generating, and comprehensive decision-making. Categories of communication behavior of virtual teams using a synchronous virtual room (Qureshi, 2000) include providing information, seeking information, requesting action, confirming action, seeking consensus, stating a problem, stating a solution, notifying of the occurrence of an event, making a decision, volunteering assistance, raising funds, seeking funds, providing funds, and providing humor. The first two, providing information and seeking information, were the most frequently observed behaviors in this case study. Robey et al. (2000) categorized communication differently, sorting it into three types: communication for cultural understanding, task-related communication, and socio-emotional communication.

Cramton (2001) explored thirteen virtual teams' difficulties in maintaining "mutual knowledge" and described the consequences of failure to do so. She identified five types of problems constituting failures of mutual knowledge: failure to communicate and retain contextual information, unevenly distributed information, difficulty communicating and understanding the salience of information, differences in speed of access to information, and difficulty interpreting the meaning of silence. These difficulties were associated with episodes of conflict, frustration or confusion in the teams.

Trust in traditional teams was an important component, but in virtual teams, it is an even more important quality (Lipnack & Stamps, 1997). GVT members have to trust other people, share purposes and rewards, and trust their information channels, and GVT members have only their shared trust in one another to guarantee the success of their joint work (Lipnack & Stamps, 2000). This is not only a theoretical claim, but also it is evident in empirical study results (Buckley, 2000), which find that trust accounts for a quarter of the variance observed in virtual team effectiveness. Morris, Marshall and Rainer (2002) found that trust and user satisfaction with the IT used explained 31% of the variance in job satisfaction of virtual team members.

The factors identified as sources of trust in the traditional FTF context were examined in a study of the virtual team setting by Jarvenpaa et al. (1998). They reported that team members act as if trust is present from the first interaction. Explicitly, GVTs experience "swift trust," which is temporal and very fragile (Jarvenpaa & Leidner, 1999). The concept of swift trust was developed to describe trust in temporary teams, which form and function around a common temporal task. Swift trust might be imported to the virtual teams but is more likely to be created via the communication behaviors of

group members during the first interaction they experience together. Furthermore, task communications are crucial, while social communication that complements the task may strengthen trust in the teams. Response behavior and verbalizations of member commitment are also critical for trust development (Jarvenpaa & Leidner, 1999). Jarvenpaa, Shaw, and Staples (2004) suggest that the impact of trust on global virtual teams is different in different situations (context). Furthermore, training can increase the level of trustworthiness and trust among team members, and encourage team members to be open and frank in expressing their feelings and ideas (Beranek, 2000; Warkentin & Beranek, 1999). Training enables virtual teams to develop trust faster than do teams with no training as well as to increase levels of trustworthiness.

Kanawattanachai and Yoo (2002) examined the dynamic nature of trust and its changing patterns with 38 teams in a simulation game. They focused on cognitive-based trust, which is based on elements such as competence, reliability, and professionalism, and on affective-based trust, which is based on elements such as caring and emotional connection to each other. The study compared both affective-based and cognitive-based trust between high- and low-performing teams over time. They found that both high- and low-performing teams started with similar levels of trust in both cognitive and affective dimensions. Unlike the low-performing teams, better development and maintenance of trust level throughout the project life were attributed to the high-performing teams. Commitment to a virtual team influences satisfaction and performance and, moreover, findings suggest that commitment to the virtual team can be manipulated (Powell, 2000). Furthermore, this study found no significant relationship between commitment to the virtual team and task competence, personality, and others' commitments. Training can improve not only communication, but also increase the commitment of team members to the team's goals and objectives (Warkentin & Beranek, 1999; Beranek, 2000).

Leadership is another important factor for team effectiveness in traditional collocated teams. Leaders in GVTs face challenges that are different from the traditional FTF environment (Oakley, 1998; Switzer, 2000). Leaders' aggressiveness and assertiveness, for example, are directed by cultural norms (O'Hara-Davereaux & Johnsen, 1994). As a result, the GVT leader must develop a style that will fit the cultural composition of its team members and optimize the cultural differences (Oakley, 1998; O'Hara-Davereaux & Johnsen, 1994) Lurey and Raisinghani (2001) suggest that leadership style is related to virtual team effectiveness only moderately.

Switzer(2000) found no differences in leadership profiles between the virtual and FTF group leaders. Hara, Bonk, & Angeli (2000) found that discussion leaders influence cognitive and metacognitive depth of students' online discussions.

Leadership is the main focus of Kayworth and Leidner's study (2001) of thirteen GVTs comprised of students from the USA, Mexico, and France. The goal of their study is to identify the factors that contribute to effective leadership in a virtual team environment. Their quantitative analysis reflects that a significant predictor of leadership effectiveness in the virtual environment is the mentoring capability of the leader. Furthermore, effective leadership is associated with team members' perceptions of communication effectiveness, communication satisfaction, and the ability of the leader to establish role clarity among team members. Importantly, their qualitative analysis is consistent with the literature on face-to face teams (Kayworth & Leidner, 2001). All of this research suggests four dimensions of effective virtual team leadership: 1. Communication (the leader provides continuous feedback, engages in regular and prompt communication, and clarifies tasks); 2. Understanding (the leader is sensitive to schedules of members, appreciates their opinions and suggestions, cares about member's problems, gets to know them, and expresses a personal interest in them); 3. Role clarity (the leader clearly defines responsibilities of all members, exercises authority, and mentors virtual team members); and 4. Leadership attitude (the leader is assertive yet not too "bossy," caring, relates to members at their own levels, and maintains a consistent attitude over the life of the project).

Majchrzak et al. (2000b) conclude that in the virtual team, the decision-making shifts from hierarchical in nature to more participative due to the adoption of technology. The leader's role becomes more ambiguous in the virtual team in that the leader is not the information gatekeeper but rather a negotiator and facilitator. The leader of this team complained that, "I've never seen a rocket designed by committee before" (Majchrzak et al., 2000b, p. 588). The same type of change in the position and roles of the leader of a virtual team is evident in the case study of a virtual team in the automotive industry (May, Carter & Joyner, 2000). The researchers stress that the use of groupware and adoption of it by the virtual team enabled more delegation of responsibilities down to team members. In addition, the uncertainty that members of virtual teams face creates the need for a rotating leadership strategy in order to avoid dependence on any particular member (Jarvenpaa et al., 1998; Johnson, Suriya, Won Yoon, Barrett & La Fluer, 2002).

Another impact on virtual team effectiveness is managerial control. Piccoli & Ives (2003) indicate that the managerial behavior control mechanism used has a negative effect on individual psychological outcomes and has no effect on team performance and team member viability. Therefore, different managerial solutions (from the traditional control mechanisms) should be implemented in order to increase virtual team performance (McDonough et al., 2001; Piccoli & Ives, 2003).

Conflict management behavior in GVTs is the focus of a study by Montoya-Weiss et al. (2001) that also examines the effect of temporal coordination intervention on team effectiveness. Based on the five conflict-handling modes rooted in the research on face-to face teams—avoidance, accommodation, competition, collaboration, and compromise—they have generated hypotheses with regard to the effect of each of these behaviors on virtual teams. Accommodation and compromise behaviors generated different effects than were expected based on the traditional team literature. Accommodation had no significant effect on performance of virtual teams, and compromise behavior had a significant negative effect on performance of virtual teams. One of the explanations for the minimal effect of accommodation behavior could be that "no matter how much an individual may express accommodation; the team does not experience it" (Montoya-Weiss et al., 2001, p. 1257). The significant negative effect of compromise behavior can be explained as follows: "It may be that compromise behavior was manifested as 'cutting and pasting' content in order to develop a middle of the road, representative team document" (Montoya-Weiss et al., 2001, p. 1259).

The final factor in the internal environment is norms development. Norms development is explored in a study by Malhotra, Majchrzak, Carman and Lott (2001). They stress that one of the managerial challenges for a virtual team is coordinating norms: "Communication protocols about what gets communicated to whom, when, and how, can be established at the outset and aid team success" (Malhotra et al., 2001, p. 233). The set of norms and behaviors that helps the team communicate about their task in the virtual setting is the focus of a study involving engineers by Majchrzak et al. (1999, 2000a). The authors report on norm development and adaptation of inter-organizational virtual teams using collaborative technology that focuses on knowledge sharing and re-use. At the kickoff team meeting, this team set up a coordination protocol that included 11 formal norms prepared in advance by a subgroup of the teams and modified during the first meeting. Many of these norms were later called into question, and the need for new practices and norms was evident. During the team's first working period, 15 modified norms were set up, which were replaced with nine norms after the first team's technical review, a process which facilitated the knowledge-sharing process in this team. It is clear that effective communication protocols are difficult to define a priori, as during the team development, team norms change as well (Malhotra et al., 2001). The team in this case study adopted a practice of democratic participation and encouraged the use of "common language" metaphors. Since in virtual teams one cannot assume that members bring shared understanding to the team through common affiliation with one organization or profession, shared understanding must be created (Malhotra et al., 2001).

In this section, we described several unique components of the internal environment in our framework: technology use and boundary spanning. These factors and other internal factors were recognized by other researchers to support VTE. In the following section, we further discuss effectiveness.

Effectiveness

Effectiveness has been the focus of several frameworks for traditional teams as well as VTs. Effectiveness could refer to whether the team has accomplished its assigned tasks (Shea & Guzzo, 1987). Another approach embraces socioemotional consequences of group action, such as member satisfaction and attraction to the group as elements of effectiveness (Hackman, 1987). Many researchers agree that effectiveness includes more than performance (Hackman, 1987; Pearce & Ravlin, 1987; Sundstrom, et al., 1990).

Beyond these two more traditional effectiveness measures (performance and satisfaction), an effective virtual team creates and maintains a shared digital space during a team life-cycle. This shared electronic space, could be preserved for future use by the organization and other teams (Furst, Blackborn & Rosen, 1999).

FUTURE TRENDS

In the online learning environments, internal environments gain more attention than other components (boundaries and external environments) in the past. For example, dealing with various technological configurations was found as a major setback in a study of a web-based distance education course (Hara & Kling, 2000). This issue was embedded within external environment and was not anticipated as a problem. In addition, how the external environments, such as participation forces and autonomy and control systems, influence learning environments is discussed thoroughly in Kling and Courtright's work (2004). Moreover, teachers who traditionally assume the role of leaders become more like facilitators in online learning environments (Wallace, 2003). This new role of instructors affects their communication strategies, norm development, and eventually trust among students. Our wish is that the ecological model, which was originally developed for virtual teams in organizational setting (Shachaf & Hara, 2002), will help understand VTE in instructional settings as well.

Another emerging trend in online learning is the emphasis on building learning community (Barab, Gray, & Kling, 2004). Instructors can facilitate developing a sense of belongingness to the learning community through peer-to-peer learning occurred in VLE. One strategy is to put emphasis on social aspects of students' interactions. Learning is social (Lave, 1988; Vygotsky, 1978). Instructors could provide a virtual space called "coffee table" where students can engage in social discussions, such as hobbies and other interests. As the corporate world show keen interests in building communities of practice both online and face-to-face (Wenger, McDermott, & Snyder, 2002), instructors should consider providing learning community for students.

CONCLUSION

In this chapter, we proposed an ecological framework to understand VTE. This framework consists of three components: external environment, internal environment, and boundaries. We proposed reciprocal interdependency among the three components and VTE, by stressing the effects of components on VTE, and vice versa, the effects of VTE on the three components. The significance of the proposed framework is threefold. First, we internalized technology, which is traditionally a contextual variable in team effectiveness models, and stressed its roles and impacts as a part of internal environment on VTE. Second, boundary management, as well as boundary spanning effects, was explained in relation to VTE, whereas most traditional frameworks tend to ignore this aspect. Third, we expanded on the factors of the external environment of VT as they relate to virtual learning

team effectiveness; specifically, we delineated the factors of the microsystem. Evidently, further empirical study to validate this framework is yet to be done both in business and instructional settings. We do hope that this framework will inform other researchers' studies to consider environmental aspects and not only examine this phenomenon under closed systems perspectives when studying VTE.

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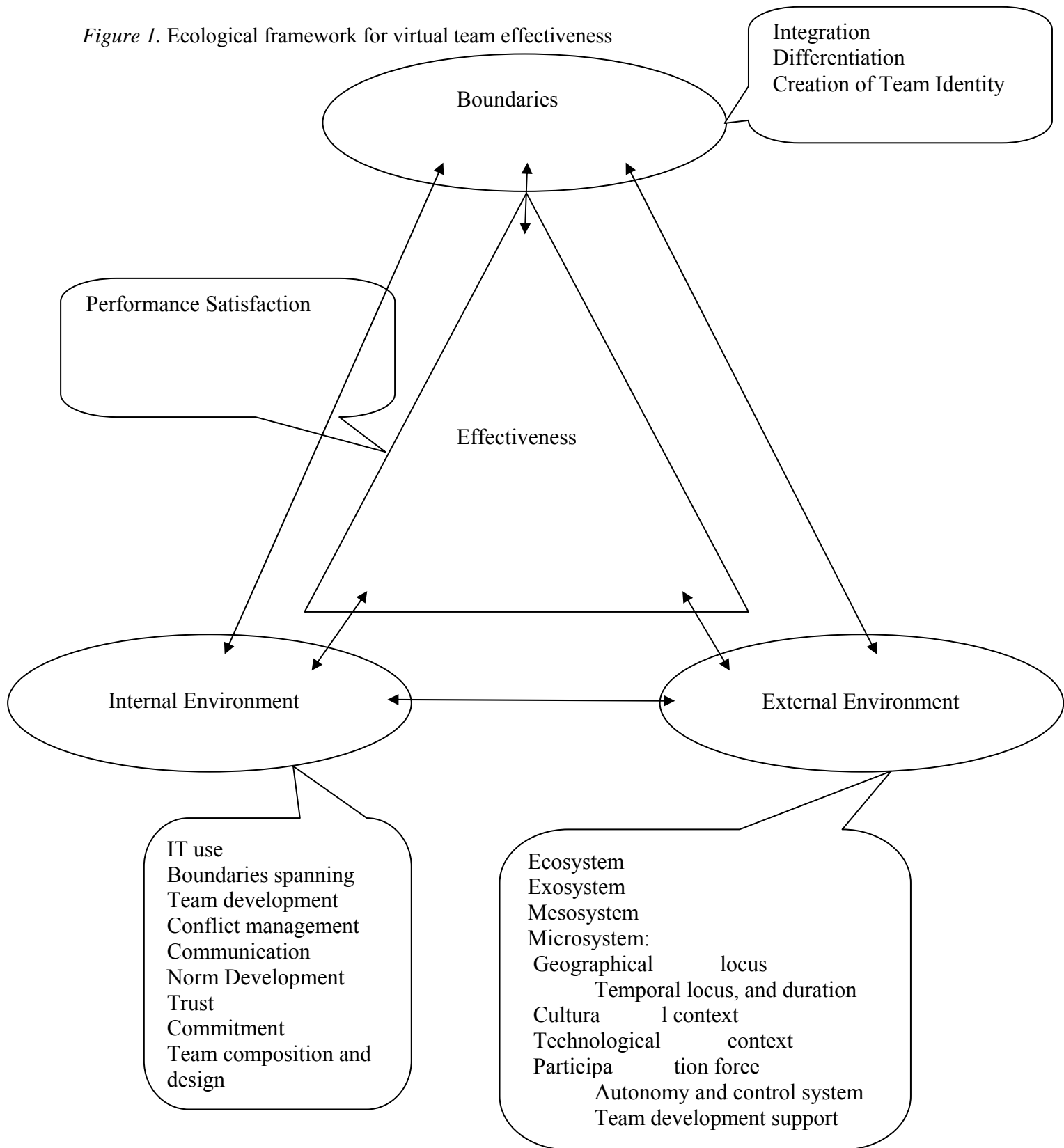*Figure 1.* Ecological framework for virtual team effectiveness

Boundaries

Integration
Differentiation
Creation of Team Identity

Performance Satisfaction

Effectiveness

Internal Environment

External Environment

IT use
Boundaries spanning
Team development
Conflict management
Communication
Norm Development
Trust
Commitment
Team composition and
design

Ecosystem
Exosystem
Mesosystem
Microsystem:
 Geographical   locus
         Temporal locus, and duration
 Cultura   l context
 Technological   context
 Participa   tion force
         Autonomy and control system
         Team development support

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Figure 2. External environment