A Framework to Evaluate the Performance and Satisfaction of Virtual Teams in On-line Learning Environment

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Abstract: This paper describes the development of a framework which can be used to evaluate the performance and satisfaction of virtual teams in an online education environment. A comprehensive literature review of existing virtual team research is used to develop a framework and this is then substantiated against existing theories in relation to Computer Mediated Communication (CMC). The framework is distinct and feasible; provides social and task dimension; and provides the relationships between variables. In addition, each variable is discussed and the clues of methodology design are presented.

1 Overview

It has long been acknowledged that computer networks have changed the way that people and organizations work and communicate [Anderson & Shane 02]. One such consequence is the emergence of 'Virtual Teams' where members interact via a CMC system rather than in a face-to-face environment [Driskell & Radtke 03]. This is particularly prevalent in the area of education where online studies reach a wider population without a substantial increase in resources [Lipnack & Stamps 00].

While virtual teams can generate considerable cost savings it has been found that the performance and satisfaction of virtual teams rarely matches up to that of traditional face-to-face teams [Warkentin et al. 97][Galegher & Kraut 94][Straus 97][Valacich & Sarker 02] with only a few studies finding relatively little or no difference [Sharda et al. 88][Burke & Chidambaram 96]. It is suggested that the inherent difficulties in establishing intimacy and bonding among the members of virtual teams results in a reduction in decision-making quality and satisfaction [Valacich & Sarker 02][Warkentin et al. 97].

Many varied constructs have been identified as impacting on the performance and satisfaction of virtual teams. For example, [Driskell et al. 03] studied the relationships between cohesiveness, status processes, counter normative behaviour and communication; [Ancona & Caldwell 92] explored the relationships between diversity

and performance; [Anderson & Shane 02] found that netcentricity contributed to the performance of virtual teams; [Balthazard et al. 04] discussed the relationships between performance of virtual teams and expertise, extraversion and group interaction styles. Some researchers focus on task dimension [Bradley et al. 03][Kirkman et al. 04][Janz et al. 97], while others focus only on the social dimension [Matveev & Nelson 04][Chin et al. 99]. Clearly there is a need for studies focusing on both task and social dimensions in relation to performance. This study examined these issues in the context of online education and specifically addressed the questions:

1. Are there any specific social or task factors that affect the performance and satisfaction of virtual teams?
2. How do the factors affect each other and what impact do the factors have on the performance and satisfaction of virtual teams?

As a first step, a comprehensive literature review of virtual team research has been undertaken to allow the researchers to develop a framework for the study. This is described in the following section and validated against existing theories in relation to CMC. The Periodic Table, Media Richness, SIDE and SIP are explored and applied to the framework. Then, each variable is discussed in relation to the case study or filed experiment and the design of instructions. In the end, the advantages of this framework and future research are addressed.

2　　On-Line Education Environment

The environment of recent research in virtual teams is twofold: real world and school. A real world environment of virtual teams focuses on global virtual teams. Such as [Kock & Lynn 05] studied 290 new product development teams that conducted variable company projects located in North-eastern US. School environment is divided into two types that both subjects are students. The first type focuses more experimental design and control mechanism. Such as a study by [Montoya-Weiss et al. 01] integrated 175 graduate students located in US and Japan to form the virtual teams. It had rigid experimental processes to control the variables and gain the expected results. The subjects are voluntary and asked to follow the rules of the experiment. Another type (i.e. field experiment) focuses on the natural settings, such as a seven-year-project HKNET [Genuchten et al. 05] combined the students of the six universities in Hong Kong, Florida, Tilburg, Eindhoven, Grenoble and Beijing to form virtual teams. This kind of environment has less control variables and focuses on the natural settings to observe the subjects.

For the comparison of the two environments (real world and school), real world environment is not easy to be obtained and may have more bias to evaluate the relationships between research variables due to the difficulties of controlling the whole variables. Comparatively, school's environment is pure and easy to be obtained and manipulated. Thus, most virtual team research has used this environment. Among school's environment, experimental environment is excellent at controlling the variables and can precisely conclude the relationships between variables. But, the environment is difficult to be reproduced and transplanted to real life, and thus the external validity is weak. On the contrary, although few variables are controlled in

natural settings environment may cause the difficulty to duplicate the project in the future and some uncontrolled variables may affect the results, it makes the participants work in a natural setting and leads to greater generalisability (external validity) of result and construct validity [Judd et al. 1991].

Although each environment has its value to be employed, this study focuses on the natural settings in the on-line education environment. In this environment, students can interact naturally and few variables are controlled. [Moore 89] identified the three kinds of interaction of on-line learning: learner-content, learner-instructor, learner-learner. Among them, interaction of students seems to be one of the most influential factors of on-line learning [Swan 01]. A study by [Fulford & Zhang 93] suggested that students' perceptions of interaction are important indicators of the satisfaction with instruction. Similar studies [Picciano 98] [Jiang & Ting 00] also explained that students' perceived learning from online courses was related to the amount of discussion. These studies implied that students' interaction in the on-line learning is crucial for their performance and satisfaction. Thus, this study focuses on the processes of students' interaction in the on-line learning environment.

3   Literature Review of Virtual Teams

According to Social Presence Theory [Short et al. 76] and Media Richness Theory [Daft et al. 87], the less information available within a medium, the less attention is paid by participants. Both theories argue that the lack of information conveyed by CMC such as facial expression, posture, dress and nonverbal cues, leads to lower communication effectiveness. This result corresponds with the findings of research by [Bordia 97] analysing 18 studies (1985-1994) comparing face-to-face and CMC.

[Powell et al. 04] reviewed 43 research studies (1988~2002) about virtual teams and proposed a detailed framework for future study of virtual teams. The framework includes four general constructs: "inputs", "socio-emotional processes", "task processes" and "outputs". "Inputs" focuses on the pattern and composition properties of virtual teams, such as team, culture, technical abilities and training. "Socio-emotional processes" concerns the building of social relationships between team members. This includes cohesion and trust. "Task processes" relates to the processes that team members use to cooperate in order to complete a task or reach a goal. The components are communication, coordination and task-technology-structure fit. "Outputs" refers to the outcomes in relation to both performance and satisfaction. The framework is shown as below in Figure 1.

The advantage of this framework is that it presents the key issues identified in relation to virtual teams and acts as a starting point for any researcher in this area. An analysis of each of the contributing factors allows the researcher to develop a revised framework for the specific research environment under study. For example, [Driskell & Radtke 03] found that past research on virtual teams paid too much attention to developing advanced technological environments instead of social and psychological dimensions. So the emphasis within a new study may shift the balance by revising the framework.
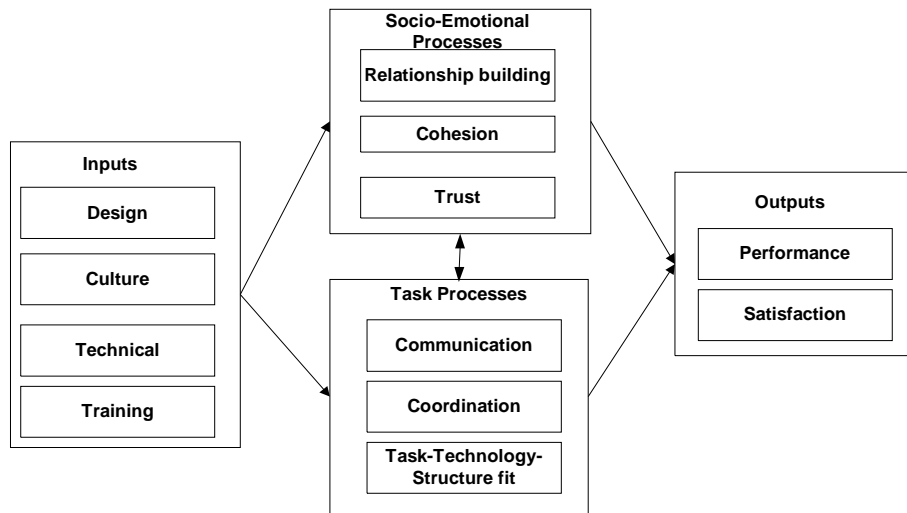
Figure 1: Powell's et al. (2004) framework of virtual teams

Within the "Socio-emotional processes" dimension, the concept of "trust" in virtual teams has been widely researched [Morris et al. 02] [Erdem & Ozen 03]. Indeed this area has taken on a life of its own and Appendix 2 highlights the extent to which 'Trust' has been shown to inter-relate with a myriad of other concepts.

"Trust" is actually excluded for three reasons:

1. Firstly, past studies show that trust is a not only an extensive but incongruous issue for team research. For example, [Li et al. 04] studied trust over multi-dimensions: cognitive trust, calculative trust and institutional trust; [Clases et al. 03] studied the correlation of trust to personal bonding and shared experiences. [Mayer et al. 95] studied trust in regard to the ability, benevolence and integrity factors. Appendix 2 aggregates Clases et al. fifteen studies on trust and shows the multi-dimensions of issues impacting on trust. As yet, there has been little convergence in research studies in this area and while recognized as a critical area it merits individual study;

2. Secondly, this study focuses on a specific environment: student on-line learning. The interaction of students with teachers and other students follows a similar pattern as seller and buyer. There is an obligation and pressure for students to cooperate to finish the tasks that teachers assigned. Even if students do not trust others they still have to endeavour to work together. Therefore trust in the socio-emotional sense may be seen to be a less important issue in this environment;

3. Finally, in the on-line learning environment with natural settings, the forming of virtual teams is always pre-selected by lecturers from a single large cohort of students (it could be randomly selected). While 'trust' may be a factor it should impact equally on all teams and so is excluded from the comparison between teams.

Similarly, the concept of "task-technology-structure fit" will also be excluded from this study. [Powell et al. 04] stated that there is a need to determine the tasks suitable for various technologies, the tasks suitable for a particular structure, and the technology adopted by team members to form a new structure over time. However, in a learning environment, the tasks are always assigned by the lecturers. Students may use the tools (Blackboard or WebCT) provided by the school to communicate with each other and structured change is minimal. Thus, "task-technology-structure fit" should be a fix factor in an on-line learning environment. This also applies to the inputs part of the framework of Powell et al., design of teams is redundant because the structure of teams is fixed; culture is similar to trust in the sense that all team members share the same organisational culture and are drawn from a single cohort incorporating many ethnic cultures and so a mixed culture is common to all teams equally; technology is fixed and training of students is through a structured process and can be viewed as a constant variable. Finally, the authors believe that collaboration rather than coordination is more suitable for this study given that this is a learning environment. The revised framework of this study is therefore as below:
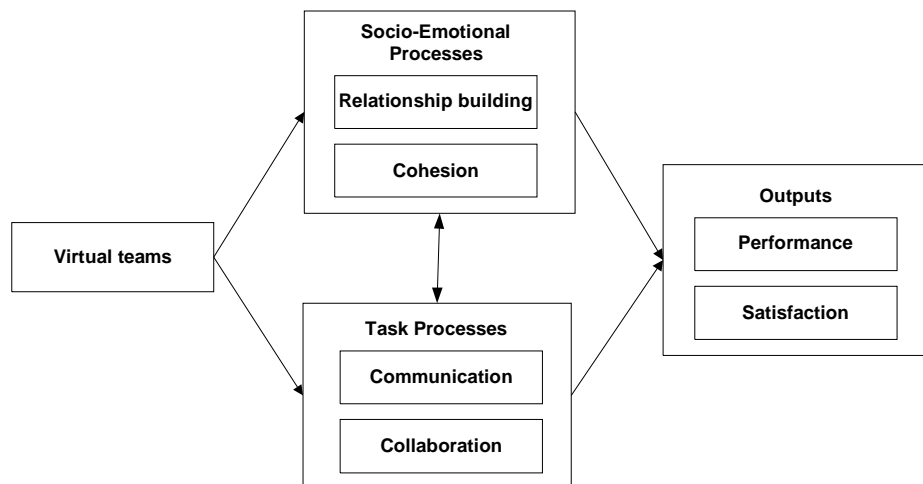

Figure 2: The framework of this study

4   CMC Theories

CMC has been found to promote interpersonal relationships between team members in the early development of teams [Maznevski & Chudoba 00][Robey et al. 00]. However, if there is an absence of face-to-face meeting, the teams might exchange social cues through CMC to build relationships [Robey et al. 00]. Relationship building can strengthen feelings of inclusiveness or a sense of belonging to teams and further foster cohesion [Powell et al. 04]. Cohesion has been considered to be the most important small group variable [Lott & Lott 65]. It has been associated with

better performance and satisfaction [Lurey & Raisinghani 01][Maznevski & Chudoba 00].

It is possible that periodic face-to-face meeting promises the improvement of coordinating members' activities and ensuring the project progress [Maznevski & Chudoba 00]. However, if face-to-face meeting is not feasible, exchanging information through CMC fosters the coordination and collaboration of virtual teams [Tan et al. 00]. Collaboration also has been linked to performance of teams [Johansson 99][Mayer et al. 95]. Figure 3 summarizes the results of those studies, showing the connection between relationship building, cohesion, communication, collaboration and performance.
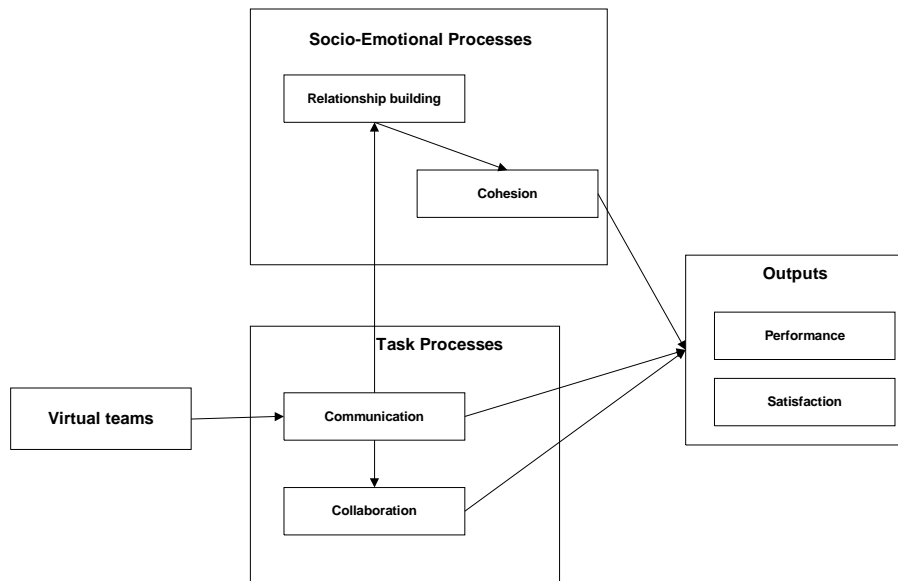

Figure 3: The relationship of all concepts

[Kirkman et al. 04] suggested that extensive training helps overcome process loss in leadership, conflict management and meetings management. In addition, use of behavioral interviewing techniques and panels to help new members can balance technical and interpersonal skills to avoid misuse of technology. [Solomon 01] found that providing proper technology for communication, understanding the needs of the team and creating a sense of shared space can help virtual teams improve both performance and satisfaction. [Markus 94] recommended that better IT support, adhesive relationships and better work practices can improve the performance of virtual teams. Hence task orientation (such as communication and collaboration) and social orientation (relationship building and cohesion) are both important for improving the performance and satisfaction of virtual teams.

5   Application of Theories

In earlier studies of CMC, theories such as the Social Presence Model [Short et al. 76] and Media Richness Theory [Daft & Lengel 84][Daft & Lengel 86][Daft et al. 87], found that the virtual environment lacking in socio-emotional aspects. More recent theories suggest that these relationships can, nevertheless, be developed in the virtual environment. This section introduces four theories: The Periodic Table, Media Richness, SIDE and SIP. "The Periodic Table" is used to provide a holistic view of this study. Other theories are introduced individually and applied to the framework in section 5.5.

5.1   The Periodic Table

"The Periodic Table" (Figure 4) was developed by [Lipnack & Stamps 00]. On the horizontal dimension, it contains inputs, processes and outputs. The elements on the vertical dimensions are purpose, people, links and time; each of these vertical dimensions follows the procedure illustrated by the flow chart (inputs➔system➔outputs), and is independent of each other. As the flow chart indicates, the system receives input from one of the horizontal dimensions, and then it processes the element to produce the corresponding output. The output is also directed back to the input to strengthen or weaken the force of the current progression on subsequent inputs.

	Inputs	Processes	Outputs
Purpose	Goals	Tasks	Results
People	Members	Leadership	Levels
Links	Media	Interactions	Relationships
Time	Calendar	Projects	Life Cycles
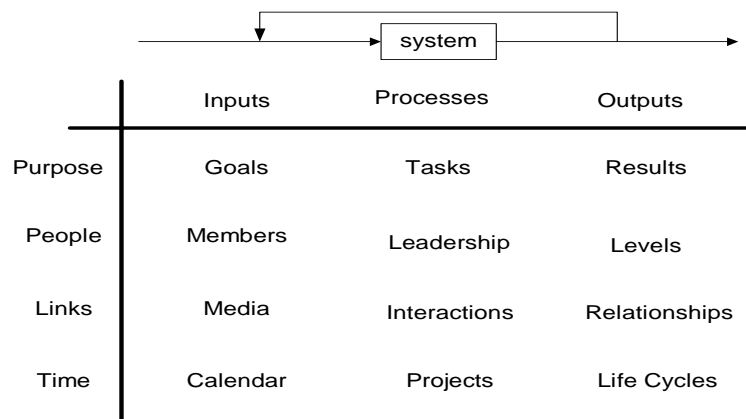
Figure 4: The Periodic Table of virtual teams

This model presents an intact view of virtual teams' working process and is easy to understand. However, there are some defects in this model. Firstly, the model does not explain the relationships between vertical dimensions, such as the relationships between links with purpose and people; the link's change by time; and the relationships between people and purpose. Secondly, the model does not explore the relationships between elements. For example, media and goals may affect the task; leadership and tasks may influence results.

This model also supports the two dimensions of this study: "socio-emotional processes" (i.e. people dimension) and "task processes" (i.e. purpose dimension).

5.2   Media Richness Theory

[Daft & Lengel 84][Daft & Lengel 86][Daft et al. 87] developed Media Richness theory. The theory suggests that organizational success is based on the organization's ability to process information of appropriate richness to reduce uncertainty and clarify equivocality. Uncertainty means the absence of information. When information increases, uncertainty decreases. Equivocality implies ambiguity and the existence of multiple and conflicting interpretations about a certain situation.

Information richness is the ability of information to change understanding with a time interval. There are three ways to identify the richness of media: immediate feedback, the number of cues and channels utilized, personalization and language variety [Daft & Wiginton79]. According to this definition, face-to-face is the richest media because it provides immediate feedback, manifold cues (such as body language, eye contact and tone of voice) and message implication expressed in natural language. CMC is suitable for task-oriented jobs rather than social-oriented jobs. This is similar to the Cuelessness Model [Kemp & Rutter 82] and Reduced Social Cues approach [Kiesler 86][Siegel et al. 86].

The results of testing Media Richness theory vary. For example, [Markus 94] tested the theory by observing the using of electronic mail and found that employees preferred email for informational messages and telephone for personal message. [Zack 94] compared Electronic Messaging (EM) and traditional communication (face-to-face, telephone and memo) and reported that EM was not a substitute for face-to-face interaction. However, EM is an effective communication tool when members shared interpretative context.

[Schmitz & Fulk 91] examined the effects of perceived media richness and social influences from organizational colleagues on the uses and assessments of electronic mail. They found that perception of media richness was not dependent on the features of the media but rather on the experience of using a computer, such as keyboard skills and experience of software. The greater the experience of using computers, the higher perceived richness of media. [D'Ambra et al. 98] tested the Media Richness theory and found that media richness might not be the only predictor of media choice for task equivocality. They concluded that the richness of media is perceived multi-dimensionally in terms of the information carrying capacity of media.

5.3   Social Identity and Deindividuation (SIDE) Model

The SIDE model was developed by [Lea & Spears 91] to overcome the insufficient theoretical foundation of earlier CMC. It provides a more comprehensive model by focusing on Social Identity (SI) theory and a re-conceptualization of de-individuation. The SIDE model believes that the visual anonymity and physical isolation of members in a CMC environment should incur deindividuation and the lessening effects of the individual's social or personal identity. Users' behaviour in CMC

environment is different and depends on the salient identity in the particular situation. When group norms are strong, identity will be salient and there is coincidence between individual behaviour and group normative behaviour. In situations where group norms are weak, personal identity will become salient and behaviour will be in line with personal norms. To simplify the SIDE theory, in the CMC environment, when participants communicate through visual anonymity (the physical cues such as face-to-face communication is unavailable to identify others as individuals), they are deindividuated. In this situation, when a group identity is formed instead of an individual identity, it facilitates the social relationships such as shared norms.

The SIDE model suggests that the reduction of social cues in CMC environment does not equate to the reduction of social context. Although there are less social cues, the remainder can still support in formation of an impression of partners. It can convey social information, aid in regulating behaviour and provide a social context for communication and relationship building.

Several studies have tested the SIDE model. [Postmes & Spears 98] reviewed studies about SIDE model to examine the impact of properties of CMC on social influence and summarized that group identity was salient, anonymity increased social identity with group, group attraction, conformity to group norms and stereotyping by depersonalising perceptions of the self and others. In addition, they conducted a meta-analysis of deindividuation theory and the result showed little support for (a) the occurrence of deindividuated behaviours or (b) the existence of a deindividuated state, but support for a social identity model of deindividuation effects. The researchers explained that this might be caused by situation-specific rather by general social norms. However, the SIDE theory still be relevant to this study.

5.4   Social Identity and Deindividuation (SIDE) Model

Due to the discrepancy between "cues-filtered-out" [Culnan & Markus 87] and the findings from field research that personal relationships did develop in a CMC environment, [Walther 92] developed the Social information Processing (SIP) perspective of CMC. SIP is based on the assumption that people seek to affiliate in their communication. People form initial impressions of each other based on the exchange of social information. In a CMC environment, as the amount of textual messages increase, partners are tested and interpersonal impressions adjusted. Then, interpersonal relationships and personalized communication develop over time and the conversation tends to be personal instead of impersonal. Although with the reduction of social cues conveyed in CMC, the SIP believes that impression formation and relational communication still can be established as long as adequate time is given. This phenomenon was called "hyperpersonal communication" [Walther 96]. [Walther 96] defined hyperpersonal commnucation as "CMC that is more socially desirable than we tend to experience in parallel FTF interaction" (p17).

For developing relationships in CMC, members must be motivated to form relationships and impressions through interpreting the available social cues. The reduced social cues in CMC still enable members to manipulate their self-presentation to project a favorable image. In the absence of contradicting information,

members may form idealized stereotypical impressions based on the available social cues and selective self-presentation.

The SIP suggests that VT and FTF may operate at different rate instead of capability. That means due to the limitations of CMC, the media cannot convey all the information for task and social need in as little time as FTF communication. However, users can adapt into the nonverbal messages and exchange social information over time. A meta-analysis of study by [Walther et al. 94] provided evidence of this aspect. The study reported a higher percentage of social-oriented communication and smaller differences between FTF and CMC group in unlimited time groups than in restricted time groups.

5.5   Applying the Theories to The Framework

From the preceding discussion, it can be seen that the concepts in the "Periodic Table" can be applied to the "virtual teams" dimension, "Media Richness" can underpin the "Task Processes" dimension and "SIP" can be applied to the "Socio-Emotional Processes" dimension. The detailed explanation is as below:

Firstly, "The Periodic Table" provides a holistic view of the study. There are four factors in the vertical dimension: purpose, people, links and time. Purpose implies "Task Processes" while people implies "Socio-Emotional Process". "Links" presents communication and include three components: media, interactions and relationships.

Next, Media Richness theory suggests the belief that CMC is more suitable for task-oriented jobs. "Task Processes" dimension is to explore how the members communicate, collaborate and affect the teams' performance and satisfaction in the virtual team settings.
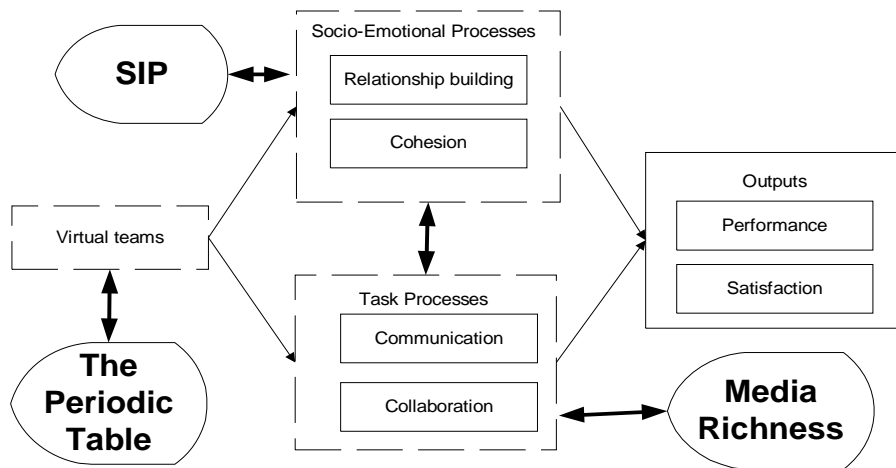

Figure 5: The theories applied to this study

Furthermore, there are three key issues of SIP. First, members seek for affiliation in their communication, then members are motivated and third is the most important one: time. SIP enforces the belief that members of VT can develop social relationships equally as good as FTF as long as adequate time is available. "Socio-Emotional Processes" dimension is to figure out how the virtual team members build social relationships and how the social teams.

Finally, the two-way arrow between "Task Processes" and "Socio-Emotional Processes" is showing the interaction between the variables. Except the relationships in Figure 3, it is valuable that exploring the effect of "Socio-Emotional Processes" dimension factors on "Task Processes" dimension factors and futhermore how their interaction affect the performance and satisfaction.

6   The Exploration of Each Variable

The following sub-sections introduce each variable in the framework of this study (Figure 2). The purpose of this section is to give a detail and comprehensive understanding of each variable and furthermore it is enabled to design the case study or field experiment, and develop instructions to validate the framework and explore the relationships between variables (Figure 3).

6.1   Communication

6.1.1   Communication in Virtual Teams

Although some researcher argue that the communication in electronic communication has decreased due to the lack of speech acknowledgements (e.g., "hum?" "Uh-hmm") and social greetings [O'Connail et al. 93][Sarbaugh-Thompson & Feldman 98], there is no doubt that the electronic communication consumes more time and conversation contexts. Others suggest that a problem-solving task is not suitable for electronic communication, even if the task is low in complexity [Straus 96][Gallupe & McKeen 90]. That means the efficiency of electronic communication in problem-solving tasks is lower than FTF (Face-To-Face) communication.

Message understanding is a dilemma in virtual teams. Successful communication demands the foundation of mutual knowledge and parties use physical and linguistic expression to make inferences about others knowledge [Hollingshead 98]. A study by [Marshall & Novick 95] demonstrated that conversation still goes well and message understanding is fine after removing the visual factor. [Straus et al. 01] noted that when the visual observation is removed from communication, the evaluation of others is less stereotyped and more valid (e.g., interviewers evaluate the job applicants). Another issue of effective message understanding is time. The individual takes longer time to form impressions of others and decode social cues when communicating electronically [Sproull & Kiesler 86]. Many studies show evidence to suggest that the efficiency and effectiveness of message conveyance of virtual teams should be the same as FTF teams when adequate time is given for virtual teams [Burke & Chidambaram 96][Galegher & Kraut 94][Warkentin et al. 97]. Thus, the social and

normative context may be more crucial in electronic communication [DeSanctis & Monge 99]. Therefore, when sufficient contextual information is given, message understanding can be very high in electronic communication. Furthermore, message understanding may facilitate the relationship building and coordination in the virtual teams.

6.1.2   Related Studies about Communication

A study by [Roebuck et al. 04] stated that there are three challenges of communicating in virtual teams: lack of FTF interaction, difficulty of building relationships and challenge of accessing and leveraging the unique knowledge of each member to reach the team's goal. This study gave a murder mystery to virtual teams of business students and asked them to discuss and cooperate to solve the mystery through CMC in thirty minutes. The result showed that students can overcome the difficulties encountered in communication in virtual environment.

Despite the absence of FTF communication in virtual teams, asynchronous communication in virtual teams may be more effective in some aspects [Dufner et al. 02]. Communication in virtual teams always takes place over an extended period of time. The delay between response and feedback might provide members the opportunity to think about the problems and reflect more efficiently.

6.2   Collaboration

6.2.1   The Types and Strategies of Collaboration

There are three basic types of relationships among tasks: independent, dependent and interdependent [Chen & Lin 02]. "Independent tasks" means dual tasks have no interaction between them; "dependent tasks" means a task demands data input from another task; "interdependent tasks" means both tasks need information input from each other. To manage an independent task is easy because the task can be finished in any sequence instead of influencing others tasks. To deal with dependent tasks is also simple because the tasks can be completed in order. However, when the environment is more complex and more overlapping tasks exist, interdependent tasks occur. The interlaced input and output relationships of tasks make the coordination more difficult.

[Thompson 67] defined three types of collaborative mode – pool, sequential and reciprocal. Pooled mode occurs when the group members share activities or produce common resources, but otherwise are independent. Pooled mode is best coordinated through standardization or the development of rules that promote unified action, such as voting or polling. Sequential mode occurs when some activities of group members are dependent on the completion of others before beginning. Group members must work on the same agenda item during any time period. Reciprocal mode arises when each activity requires inputs from the others. This mode is used in more complex situations that need real time and group decision-making.

[Turoff & Rana 93] proposed five different collaborative strategies:

- Parallel: group members engage in modular sub-tasks that require little or no synchronization;
- Pooled: the whole group may need to cooperate in a loosely coupled fashion to develop a collective group output by combining the outcomes of the parallel activities. In this strategy, interdependence among the activities is low, but not all of the activities can be performed in a pure parallel mode at the individual level.
- Concurrent: group members work together and interact in a tightly coupled mode;
- Sequential: the group implicitly or explicitly adopts a plan of action and sequentialises the work process. Some of the activities require to be taken care of before moving on to the next set of activities;
- Reactive/Reciprocal: the task involves very high levels of interdependence in terms of the effects of previously performed activities and external events. The order of occurrence is not predictable in time, but event oriented.

Summarily, collaboration is divided into three basic types: pool, sequential and reciprocal. [Benbunan-Fich et al. 01] observed the collaboration strategy of virtual teams:

"They usually began their discussion by trying to solve their differences and only when the deadline was approaching, they paid attention to the worksheet questions. In asynchronous groups, most of the time was consumed in the solution of the disagreements (discrepancy reduction) or discussion of new issues that came up. During the course of the experiment, asynchronous groups had to decide how and when to proceed if they encountered missing/absent members. The rest of the team identified them when they failed to post their individual position statement by the deadline." (p6).

Furthermore, [Benbunan-Fich et al. 01] described the use of collaborative strategy of virtual teams:

"Three groups appointed a representative to compile the individual contributions and develop a group report (pooled collaboration), while two groups decided to assign each participant a different part of the final report (parallel collaboration). In the pooled collaboration mode, the compiler summarized the individual position statements based on the discussion transcripts, and posted drafts of the final reports to get approval from the rest of the team. In one online group, the compiler exercised some discretion and added extra ideas to the final report. But when the drafts were presented for approval, nobody seemed to detect or object to these extra ideas." (p6).

6.2.2   Related Studies About Collaboration

[Kraut et al. 99] studied the comparison of using electronic network and personal relationships in the collaboration of relationships of buyers and suppliers. The result shows that collaboration in an electronic network is suitable for routine work.

[Montoya-Weiss et al. 01] experimented with global virtual teams with 35 five-person teams in the United States and Japan. This study found that collaboration plays a

positive moderation role in conflict management and team performance. Some challenges of collaboration in virtual teams are as following:

1. Social cues are not easy to be conveyed, feedback is delayed and interruptions or long-time suspension in communication occur frequently in virtual teams environment;
2. Many topics might be launched at the same time. When virtual team members contribute at different time on different topics, the information might be overloaded or inadequate and the difficulty of collaboration is increasing possibility;
3. Long duration and interrupted communication may lead to discontinuous and incoherent discussions.

[Johansson et al. 99] studied the distributed collaboration of a student project about engineering software development. The result shows that communication and collaboration are extremely important issues for virtual teams. Poor communication and collaboration between managers and managers and members are the major barriers for virtual teams to achieve the goals. Poor communication causes poor collaboration. Due to the absence of FTF communication, misunderstandings occur easily and hinder the common actions. Furthermore, it causes inadequate communication and poor collaboration. By examining collaboration in greater detail, the study found that implicit expression that is caused by absence of FTF communication might be the major problem in collaboration. In the project, the members who were not continuously present omitted important development and decisions and were left behind. This results in delay or budget overrun. The study also found that collaboration is related to conflict management and commitment. Commitments are based on agreements about what is to be done, who is in charge and the deadline. Through the processes of negotiating, the management of conflict can lead to the achievement of commitment.

[Massey et al. 02] studied the effect of temporal coordination mechanism on 35 global virtual teams with 175 members and found that temporal coordination mechanism is associated with higher performance. According to [McGrath 91], there are several problems inherent in any group activities: ambiguity, conflict and scarcity of resource. The mechanism includes three approaches to handle the problems: scheduling (deadlines), synchronization (aligning the pace of effort within and between members) and allocation of resources (specifying time spent on specific tasks). It can benefit the nature of members' interaction and outcomes by reducing the uncertainty and chaos associated with tasks of teams.

[Baker 02] compared the performance of sixty-four virtual teams using four different collaborative technologies: text-only, audio-only, text-video and audio-video. The result shows that there is no significant difference between the qualities of the decisions for teams utilizing text-only versus audio-only communication. But adding video to audio-only communication resulted in a significant improvement in the quality of teams' strategic decisions.

6.3   Relationship Building

TIP Theory

[McGrath 91]'s TIP (Time-Interaction-Performance) theory offers another aspect to understand the development of relationship in virtual teams. According to TIP theory, there are three functions that are performed by group members: production, member support and group well-being. Members support and group well-being are related directly to develop relationships in the virtual teams. All functions are realized by activities that are categorized into four models:

1.   Model 1: Activities related to organization's goals and objectives;
2.   Model 2: Activities related to solution of technical issues with regard to how to reach the organizational goals;
3.   Model 3: Activities related to conflict resolution;
4.   Model 4: Activities related to execution of the requirement of organizational task.

MODES	FUNCTIONS		
	Production	Well-being	Member Support
Mode 1 Inception	Production Demand/ Opportunity	Interaction Demand/ Opportunity	Inclusion Demand/ Opportunity
Mode 2 Problem Solving	Technical Problem Solving	Role Network Definition	Position/ Status Attainments
Mode 3 Conflict Resolution	Policy Conflict Resolution	Power/ Payoff Distribution	Contribution/ Payoff Relationships
Mode 4 Execution	Performance	Interaction	Participation

Figure 6: TIP structure (By McGrath, 1991, p. 154)

TIP theory suggests that most groups follow the default path for all functions (from mode 1 to mode 4 sequentially). However, a group may use different paths for adapting to different functions (e.g. mode 1 ➔model 2➔model 4), but TIP explains that it uses the simplest path when the purposes, resources and circumstances allow.

TIP theory suggests that since members spend more time on goal and task oriented activities, it is more difficult for virtual teams to engage in developing relationships. Thus, the lack of relationship development may result in frustrated team members.

6.3.1   Related Studies about Relationship Building

Research by [Sawyer & Guinan 98] studied 40 software development teams and found that social process skills (such as the level of informal coordination and communication, the ability to resolve conflict) is more important than task skills (such as use of software methodologies and automated development tools) in project quality and team performance. Social process skills account for more than 25 percent of variation in software product quality.

Research by [Janz et al. 97] also studied software development teams. They surveyed 231 IS professionals from 27 systems development teams across 13 organizations and found that mission clarity, team collaboration and team unity is predictive of improved work outcomes, increased job satisfaction, satisfaction with personal growth and worker motivation.

6.4   Relationship Building

6.4.1   The Definition of Cohesion

The definition of cohesion varies by time and types of groups. [Carron et al. 85] defined cohesion as "a dynamic process that is reflected in the tendency for a group to collaborate and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" (p245). [Chidambaram, 96] explained cohesion as "the extent to which the group members are attracted to the group and each other" (p148).

From those definitions, three implications can be observed:
1. Cohesion changes over time in both its range and various formats throughout the process of group forming, development, sustenance and dismission.
2. Cohesion has instrumental implication. All groups are formed for specific purpose. For example, musical groups are formed for playing music. Actors gather together for movies.
3. Cohesion has an affective implication. The need to belong is a basic human motive. People want to join the groups that make them feels intimate. Thus, social bonding and task unity can produce positive effects.

Models of measurements of cohesion can be divided into two parts: unidimensional model and multidimensional model. The unidimensional model measures cohesion in single dimension, such as [Gross & Martin 52] [Piper et al. 83][Budman et al. 93]. The multidimensional model measures cohesion in multi-dimension, such as [Griffith 88][Yukelson et al. 84][Carron et al. 85][Cota et al. 95] suggested that multidimensional models have more potential than unidimensional models to evaluate what is known about cohesion. They also criticized the fact that most multidimensional models have been driven empirically. Researchers set items and collected data from individual group members. Then, sets of constructs were defined after analysis. That might be problematic because those items were too wide or narrow. If too wide, those variables might highly correlate with each other. If too narrow, it might cover incomplete perspective of the constructs.

6.4.2   Related Studies of Cohesion

[Bollen & Hoyle 90] developed a subjective conceptual model of cohesion. The model proposed that the perceptions of cohesion of group members are important for the members' behaviour. It has two dimensions: sense of belonging and feelings of morale. The measurement items of "sense of belonging" like "I feel a sense of belonging to _____", "I feel that I am a member of the _____", "I feel that I am a member of the _____ community". The measurement items of "feelings of morale"

like "I am enthusiastic about _____", "I am happy to be at [live in]_____". PCS (Perceived Cohesion Scale) was developed by the conceptual model. The model provides a different view of cohesion and was used in the groups with big population such as citizens and college.

[Chin et al. 99] used [Bollen & Hoyle 90]'s model and adjusted PCS to allow application to small groups. 330 undergraduate subjects, grouped into 70 teams participated in the experiment. Cash prizes and using the latest problem-solving information system were used to encourage students' motivation. The result supported the validity and reliability of PCS used within small groups.

[Carron et al. 85] realized that various definitions of cohesion could be classified into two major groups: group integration (GI) and individual attraction to group (ATG). GI explains "the individual's perceptions about what the group believes about the closeness, similarity and bonding as a whole and the degree of unification of the group field". ATG reflects "the individual's personal motivations to remain in the group as well as his or her personal feeling about the group". Furthermore, Carron et al. stated that both GI and ATG could be fitted into two aspects: task and social concern. Thus, a model that contains four dimensions of cohesion was developed: GI-T, GI-S, ATG-T and ATG-S. GI-T (Group Integration- Task) is GI focuses on task (i.e., collective performance, goals and objectives). GI-S is GI focuses on social concern (ie., relationship within the group). ATG-T is ATG focuses on task. ATG-S is ATG focuses on social concern.

[Cota et al. 95] pointed out that there are two advantages for Carron's et al. model of cohesion. Firstly, Carron's et al. model provides a complete view of cohesion. The task-social and individual-group dimensions can be used in many types of groups and has been identified by other researchers [Chang & Bordia 01]. Secondly, The GEQ (Group Environment Questionnaire) developed by Carron et al. has a very good explanatory ability to evaluate the issues that are important to group functioning and performance and identified by other researchers [Chang & Bordia 01].

[Dyce & Cornell 96] tested the model and GEQ in 315 musicians in 84 groups. The result supports social-task distinctions but not group-individual distinctions. [Schutz et al. 94] tested the model and GEQ in 740 high school varsity athletes to determine the degree of factorial invariance across gender (426 males, 314 females) and across type of sport teams (64 teams). The result did not support Carron's et al. model for gender and type of sport teams.

Against this criticism, [Carron & Brawley 00] suggest that the reason that these studies did not support the model and GEQ is that the varied nature of group and group cohesiveness were not taken into consideration, such as "the need to belong" and "the desire for interpersonal attachments" [Baumeister & Leary 95]. They suggested that researchers should put more focus on research questions and statistical procedures rather than the nature of group.

6.5   Relationship Building

The measurements of performance and satisfaction in VT are diverse. This study collected and analysed 10 studies from 1994 that provided the measurements to evaluate the performance and satisfaction and listed in Appendix 3.

From Appendix 3, the ways to appraise performance can be categorized into three types: grader/ranking, discussion board/videotape, questionnaires. Graders are engaged in scoring the outcome (e.g., group report). For example, lecturers or experts scored the students' group assignment [Galegher & Kraut 94]. Ranking has two sources: individual/group ranking [Straus 96][Warkentin et al. 97] and experts' ranking [Straus 96]. Individual/group ranking is done by each of members. In Warkentin's et al. study, each of the subjects ranked the certainty of their preference on a 7-point Likert scale. Experts' ranking is done by chosen experts (e.g., lecturers). Discussion board/videotape is used by [Straus 96] and [Benbunan-Fich et al. 01]. In Straus' research, the data from discussion board is analysed for group process of virtual teams. The ways of evaluating performance in questionnaires focus on perceived quality, such as meeting quality and perceived project quality [Galegher & Kraut 94], perception of discussion quality [Benbunan-Fich et al. 01], perception of learning effects [Shen et al. 01], Decision quality and perceived level of teamwork [Ocker 02]. In addition, the questionnaires used in testing performance are variable. This implies that it may be appropriate to use different scales to suit different environments.

Ways of examining satisfaction are more in agreement. The data comes from questionnaires even though the questionnaires are diverse. The two mainstreams of satisfaction are "satisfaction with the process" [Straus 96][Shen et al. 01][Ocker 02] and "satisfaction with the outcomes" [Galegher & Kraut 94][Warkentin et al. 97][Ocker 02]. In addition, other measurements of satisfaction are listed, such as fairness and solution confidence.

7   Conclusions

The contribution of this study is to provide a framework adapted from the Powell's et al. study to examine the performance and satisfaction of virtual teams in an on-line education environment. The advantages of this framework are:

(1) The framework is distinct and feasible
[Pinsonneault & Caya 2005] collected 83 empirical studies and form a framework of virtual teams listed in Appendix 1. The advantage of their framework is that it includes almost all variables in virtual team area. But, the disadvantage is that it is almost impossible to use their framework to engage in methodology design. Researchers just get a big schema of virtual teams from their framework and still need to remove a lot of redundancy to form the practical framework for each interest area of virtual teams. Comparing to their framework, the framework of this study is more feasible and specific to on-line learning environment. Adequate discussion and literature review have been taken for the framework and each variable. The

inappropriate variables have been discarded. Thus, the framework of this study is more practical and efficient. In addition, three theories (The Periodic Table, Media Richness and SIP) were applied on the framework of this study. It makes it more solid and substantial.

(2) Providing social and task dimension

It is obvious that there is a strong requirement for studying the performance and satisfaction of virtual teams along both social and task dimensions. The framework consists of two constructs (Socio-Emotional processes and task processes) and four concepts (communication, collaboration, relationship building and cohesion) that affect the performance and satisfaction of virtual teams. For considering both social and task dimension, it can have better explanation and intact schema for the virtual teams in the on-line learning environment.

(3) Providing the relationships between variables (Figure 3)

Except providing the social and task dimension, exploring the relationships between variables and the influence toward performance and satisfaction of virtual teams is important. This study also identifies the relationships between variables in figure 3 and this could act as a framework for a future study of virtual teams in an online education environment.

(4) Providing considerable literature to illuminate the future research

The study provided abundant literature within the virtual team area. They can be a good guild for the future research. In addition, each variable was discussed and clues of research methodology and instruction have been described. For example, the instruction of satisfaction, performance and cohesion, and the task design for virtual teams.

8 Future Direction

Further research is needed to validate the framework and figure out the relationships between variables through case study design or field experiment. Instruction for evaluating each variable is needed to be built. Furthermore, a longitudinal study that traces satisfaction and performance of virtual teams based on this framework will be valuable.

References

[Ancona & Caldwell 92] D. G. Ancona, D. F. Caldwell: Demography and design: Predictors of new product team performance. *Organization Science, 3*(3), 321-341.

[Anderson & Shane 02] F. F. Anderson, H. M. Shane: The impact of netcentricity on virtual teams: The new performance challenge. *Team Performance Management, 8*(1/2), 5-12.

[Balthazard et al. 04] P. Balthazard, R. E. Potter, J. Warren: Expertise, extraversion and group interaction styles as performance indicators in virtual teams. *Database for advancees in information systems, 35*(1), 41-64.

[Baker 02] G. Baker: The effects of synchronous collaborative technologies on decision making: A study of virtual teams. *Information Resources Management Journal, 15*(4), 79-93.

[Baumeister & Leary 95] R. F. Baumeister, M. R. Leary: The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497-529.

[Benbunan-Fich et al. 01] R. Benbunan-Fich, S. R. Hiltz, M. Turoff: *A comparative content analysis of face-to-face vs. ALN-mediated teamwork.* Paper presented at the Proceedings of the 34th Hawaii International Conference on System Sciences.

[Bollen & Hoyle 90] K. A. Bollen, R. H. Hoyle: Perceived cohesion: A conceptual and empirical examination. *Social Force, 69*(2), 479-504.

[Bordia 97] P. Bordia: Face-to-face versus computer-mediated communication: A synthesis of the experimental literature. *The Journal of Business Communication, 34*(1), 99-120.

[Bradley et al. 03] J. Bradley, B. J. White, B. E. Mennecke: Teams and tasks: A temporal framework for the effects of interpersonal interventions on team performance. *Small Group Research, 34*(3), 353-387.

[Budman et al. 93] S. H. Budman, S. Soldz, A. Demby, M. Davis, J. Merry: What is cohesiveness? An empirical examination. *Small Group Research, 24*(2), 199-216.

[Burke & Chidambaram 96] K. Burke, L. Chidambaram: *Do mediated contexts differ in information richness? A comparison of collocated and dispersed meetings.* Paper presented at the Proceedings of the Twenty-Ninth Hawaii International Conference on Hawaii.

[Carron et al. 85] A. V. Carron, W. N. Widmeyer, L. R. Brawley: The development of an instrument to assess cohesion in sport teams: The Group Environemnt Questionnaire. *Journal of Sport Psychology, 7*, 244-266.

[Carron & Brawley 00] A. V. Carron, L. R. Brawley: Cohesion: conceptual and measurement issues. *Small Group Research, 31*(1), 89-106.

[Chidambaram 96] L. Chidambaram: Relational development in computer-supported groups. *MIS Quarterly, 20*(2), 143-165.

[Chang & Bordia 01] A. Chang, P. Bordia: A multidimensional approach to the group cohesion-group performance relationship. *Small Group Research, 32*(4), 379-405.

[Chen & Lin 02] S. –J. Chen, L. Lin: A project task coordination model for team organization in concurrent engineering. *Concurrent Engineering: Research and Applications, 10*(3), 187-202.

[Chin et al. 99] W. W. Chin, W. D. Salisbury, A. W. Pearson, M.J. Stollak: Perceived cohesion in small groups: Adapting and testing the perceived cohesion scale in a small-group setting. *Small Group Research, 30*(6), 751-766.

[Clases et al. 03] C. Clases, R. Bachmann, T. Wehner: Studying trust in virtual organizations. *International Studies of Management & Organization, 33*(3), 7-27.

[Cota et al. 95] A. A. Cota, C. R. Evans, K. L. Dion, L. Kilik, R. S. Longman: The structure of group cohesion. *PSPB, 21*(6), 572-580.

[Culnan & Markus 87] M. J. Culnan, M. L. Markus: Information technologies. In F. M. Jablin, L. L. Putnam, K. H.

[Daft & Wiginton 79] R. L. Daft, J. C. Wiginton: Language and organization. *Academy of Management Review, 4*(2), 179-191.

[Daft & Lengel 84] R. L. Daft, R.H. Lengel, Information richness: A new approach to managerial behavior and organization design. *Research in Organizational Behavior, 6*, 191-233.

[Daft & Lengel 86] R. L. Daft, R. H. Lengel: Organizational information requirements, media richness and structural design. *Management Science, 32*(5), 554-571.

[Daft et al. 87] R. L. Daft, R. H. Lengel, L. K. Trevino: Message equivocality, media selection, and manager performance: Implications for information systems. *MIS Quarterly, 11*(3), 355-366.

[D'Ambra et al. 98] J. D'Ambra, R. E. Rice, M. O'Connor: Computer-mediated communication and media preference: An investigation of the dimensionality of perceived task equivocality and media richness. *Behaviour and Information Technology, 17*(3), 164-175.

[DeSanctis & Monge 99] G. DeSanctis, P. Monge: Introduction to the special issue: Communication processes for virtual organizations. *Organization Science, 10*(6), 693-703.

[Driskell & Radtke 03] J. E. Driskell, P. H. Radtke: Virtual teams: Effects of technological mediation on team performance. *Group Dynamics:Theory, Research and Practice, 7*(4), 297-323.

[Dufner et al. 02] D. K. Dufner, O. Kwon, Y. –T Park, Q. Peng, *Asynchronous team support: Perceptions of the group problem solving process when using a cybercollaboratory.* Paper presented at the Proceeding of the 35th Hawaii international conference on system sciences.

[Dyce & Cornell 96] J. A. Dyce, J. Cornell: Factorial validity of the group environment questionnaire among musicians. *The Journal of Social Psychology, 136*(2), 263-264.

[Erdem & Ozen 03] F. Erdem, F. Ozen: Cognitive and affective dimensions of trust in developing team performance. *Team Performance Management, 9*(5/6), 131-135.

[Fulford & Zhang 93] C. P. Fulford, S. Zhang: Perceptions of interaction: The critical predictor in distance education. *The American Journal of Distance Education, 7*(3), 8-21.

[Galegher & Kraut 94] J. Galegher, R. E. Kraut: Computer-mediated communication for intellectual teamwork: An experiment in group writing. *Information System Research, 5*(2), 110-138.

[Gallupe & McKeen 90] R. B. Gallupe & J. D. McKeen: Enhancing computer-mediated communication: An experimental investigation into the use of a group decision support system for face-to-face versus remote meetings. *Information and Management, 18*(1), 1-13.

[Genuchten et al. 2005] M. V. Genuchten, D. Vogel, A. Rutkowski, C. Saunders: Innovation in information systems education-VI HKNET: Instilling realism into the study of emerging trends. *Communications of the Association for Information Systems, 15*, 357-370.

[Green & Taber 80] S. G. Green, T. D. Taber: The effects of three social decision schemes on decision group process. *Organizational Behavior and Human Performance, 25*, 97-106.

[Griffith 88] J. Griffith: Measurement of group cohesion in U.S. army unit. *Basic and Applied Social Psychology, 9*(2), 149-171.

[Gross & Martin 52] N. Gross, W. E. Martin: On group cohesiveness. *The American Journal of Sociology, 57*(6), 646-564.

[Hollingshead 98] A. B. Hollingshead: Communication, learning, and retrieval in transactive memory systems. *Journal of Experimental Social Psychology, 34*(5), 423-442.

[Janz et al. 97] B. D. Janz, J. C. Wetherbe, G. B. Davis, R. A. Noe: Reengineering the systems development process: The link between autonomous team and business process outcomes. *Journal of Management Information Systems, 14*(1).

[Jiang & Ting 00] M. Jiang, M, E. Ting: A study of factors influencing students' perceived learning in a web-based course environment. *International Journal of Educational Telecommunications, 6*(4), 317-338.

[Johansson et al. 99] C. Johansson, Y. Dittrich, A. Juustila: Software engineering across boundaries: Student project in distributed collaboration. *IEEE Transactions on Professional Communication, 42*(4), 286-296.

[Judd et al. 91] C. M. Judd, E. R. Smith, L. H. Kidder: *Research methods in social relations* (6th ed.). Fort Worth: Harcourt Brace Jovanovich.

[Kemp & Rutter 82] N. J. Kemp, D. R. Rutter: Cuelessness and the content and style of conversation. *British Journal of Social Psychology, 21*(1), 43-49.

[Kiesler 86] S. Kiesler: Thinking ahead. *Harvard Business Review, 64*(1), 46-60.

[Kirkman et al. 04] B. L. Kirkman, B. Rosen, P. E. Tesluk, C. B. Gibson: The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. *Academy of Management Journal, 47*(2), 175-192.

[Kock & Lynn 2005] N. Kock, G. Lynn: *The E-Collaboration paradox: A study of 290 new product development teams.* Paper presented at the IRMA International Conference.

[Kraut et al. 99] R. Kraut, C. Steinfield, A. P. Chan, B. Butler, A. Hoag: Coordination and Virtualization: The role of electronic networks and personal relationships. *Organization Science, 10*(6), 722-740.

[Lea & Spears 91] M. Lea, R. Spears: Computer-mediated communication, de-individuation and group decision-making. *International Journal of Man-Machine Studies, 34*(2), 283-301.

[Li et al. 04] X. Li, J. S. Valacich, T. J. Hess: *Predicting user trust in information systems: A Comparison of competing trust.* Paper presented at the International Conference on System Sciences, Hawaii.

[Lipnack & Stamps 00] J. Lipnack, J. Stamps: *Virtual teams* (Second ed.). United States: John Wiley & Sons.

[Lott & Lott 65] A. J. Lott, B. D. Lott: Group cohesiveness as interpersonal attraction: A review of relationships with antecedent and consequent variables. *Psychological Bulletin, 64*, 259-309.

[Lurey & Raisinghani 01] J. S. Lurey, M. S. Raisinghani: An empirical study of best practices in virtual teams. *Information and Management, 38*(8), 523-544.

[Markus 94] M. L. Markus: Electronic mail as the medium of managerial choice. *Organization Science, 5*(4), 502-527.

[Massey et al. 02] A. P. Massey, M. Montoya-Weiss, Y. –T. C. Hung: *Synchronizing pace in asynchronous global virtual project teams.* Paper presented at the Proceedings of the 35th Hawaii International Conference on System Sciences.

[Matveev & Nelson 04] A. V. Matveev, P. E. Nelson: Cross cultural communication competence and multicultural team performance-perceptions of American and Russian managers. *International Journal of Cross Cultural Management, 4*(2), 253-270.

[Mayer et al. 95] R. C. Mayer, J. H. Davis, F. D. Schoorman: An integration model of organizational trust. *Academy of Management Review, 20*(3), 709-730.

[Maznevski & Chudoba 00] M. L. Maznevski, K. M. Chudoba: Bridging space over time: Global virtual team dynamics and effectiveness. *Organization Science, 11*(5), 473-492.

[McGrath 91] J. E. McGrath: Time, interaction, and performance (TIP): A Theory of groups. *Small Group Research, 22*(2), 147-174.

[Montoya-Weiss et al. 01] M. M. Montoya-Weiss, A. P. Massey, M. Song: Getting it together: Temporal coordination and conflict management in global virtual teams. *Academy of Management Journal, 44*(6), 1251-1262.

[Moore 89] M. G. Moore: Three types of interaction. *American Journal of Distance Education, 3*(2), 1-6.

[Morris et al. 02] S. A. Morris, T. Marshall, R. KellyRainer: Impact of user satisfaction and trust on virtual team members. *Information Resources Management Journal, 15*(2), 22-30.

[O'Connail et al. 93] B. O'Connail, S. Whittaker, S. Wilbur: Conversations over video conferences: an evaluation of the spoken aspects of video-mediated communication. *Human-Computer Interaction, 8*(4), 389-429.

[Ocker 02] R. J. Ocker: *The mediating effect of group development on satisfaction in a virtual and mixed-mode environment.* Paper presented at the Proceedings of the 35th Hawaii International Conference on System Sciences.

[Picciano 1998] A. Picciano: Developing an asynchronous course model at a large, urban university. *Journal of Asynchronous Learning Networks, 2*(1).

[Pinsonneault & Caya 05] A. Pinsonneault, O. Caya: Virtual teams: What we know, what we don't know. *International Journal of e-Collaboration, 1*(3), 1-16.

[Piper et al. 83] W. E. Piper, M. Marrache, R. Lacroix, A. M. Richardsen, B. D. Jones: Cohesion as a basic bond in groups. *Human Relations, 36*(2), 93-108.

[Postmes & Spears 98] T. Postmes, R. Spears: Deindividuation and antinormative behavior: A meta-analysis. *Psychological Bulletin, 123*(3), 238-259.

[Powell et al. 04] A. Powell, G. Piccoli, B. Ives: Virtual teams: A review of current literature and directions for future research. *Database for Advances in Information Systems, 35*(1).

[Robey et al. 00] D. Robey, H. M. Khoo, C. Powers: Situated learning in cross-functional virtual teams. *IEEE Transactions on Professional Communications, 43*(1), 51-66.

[Roebuck et al. 04] D. B. Roebuck, S. J. Brock, D. R. Moodie: Using a simulation to explore the challenges of communicating in a virtual team. *Business Communication Quarterly, 67*(3), 359-367.

[Sarbaugh-Thompson & Feldman 98] M. Sarbaugh-Thompson, M. S. Feldman: Electronic mail and organizational communication: Does saying "Hi" really matter? *Organization Science, 9*(6), 685-698.

[Sawyer & Guinan 98] S. Sawyer, P. J. Guinan: Software development: Processes and performance. *IBM Systems Journal, 37*(4), 552-568.

[Schmitz & Fulk 91] J. Schmitz, J. Fulk: Organizational colleagues, media richness, and electronic mail: A test of the social Influence model of technology use. *Communication Research, 18*(4), 487-523.

[Schutz et al. 94] R. W. Schutz, H. J. Eom, F. L. Smoll, R. E. Smith: Examination of the factorial validity of the Group Environment Questionnaire. *Research Quarterly for Exercise and Sport, 65*(3), 226-236.

[Sharda et al. 88] R. Sharda, S. H. Barr, J. C. McDonnel: Decision support system effectiveness: A review and an empirical test. *Management Science, 34*(2), 139-159.

[Shen et al. 01] J. Shen, S. R. Hiltz, K. –E. Cheng, Y. Cho, M. Bieber: *Collaborative examinations for asynchronous learning networks: evaluation results.* Paper presented at the Proceedings of the 34th Hawaii international conference on system sciences.

[Short et al. 76] J. Short, E. Williams, B. Christie: *The social psychology of telecommunications*. London: Wiley.

[Siegel et al. 86] J. Siegel, V. Dubrovsky, S. Kiesler, T. W. McGuire: Group processes in computer-mediated communication. *Organizational Behavior and Human Decision Processes, 37*(2), 157-187.

[Solomon 01] C. M. Solomon: Managing virtual teams. *Workforce, 80*(6), 60-64.

[Sproull & Kiesler 86]] L. Sproull, S. Kiesler: Reducing social context cues: Electronic mail in organizational communications. *Management Science, 32*(11), 427-459.

[Straus 96] S.G. Straus: Getting a clue: The effects of communication media and information distribution on participation and performance in computer-mediated and face-to-face groups. *Small Group Research, 27*(1), 115-142.

[Straus 97] S. G. Straus: Technology, group process, and group outcomes: Testing the connections in computer-mediated and face-to-face groups. *Human-Computer Interaction, 12*, 227-266.

[Straus et al. 01] S.G Straus, J. A. Miles, L. L. Levesque: The effects of videoconference, telephone, and face-to-face media on interviewer and applicant judgments in employment interviews. *Journal of management, 27*(3), 363-381.

[Swan 01] K. Swan: Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education, 22*(2), 306-331.

[Tan et al. 00] B. C. Y. Tan, K.-K. Wei, W. W. Huang, G.-N. Ng: A dialogue technique to enhance electronic communication in virtual teams. *IEEE Transactions on Professional Communication, 43*(2), 153-165.

[Thompson 67] J. D. Thompson: *Organizations in action*. New York: McGraw Hill.

[Turoff & Rana 93] M. Turoff, A. Rana: A task morphology for group decision support systems. In S. R. Hiltz & M. Turoff (Eds.), *The network nation: Human communication via computer*. Cambridge: M.I.T. Press.

[Valacich & Sarker 02] J. S. Valacich, S. Sarker: *Computer-mediated and face-to-face groups: Who makes riskier decisions?* Paper presented at the Proceedings of the 35th Hawaii International Conference on System Sciences.

[Walther 92] J. B. Walther: Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research, 19*(1), 52-90.

[Walther et al. 94] J. B. Walther, J. F. Anderson, D. W. Park: Interpersonal effects in computer-mediated interaction: A meta-analysis of social and antisocial communication. *Communication Research, 21*(4), 460-487.

[Walther 95] J. B. Walther: Relationship aspects of computer-mediated communication: Experimental observations over time. *Organization Science, 6*(2), 186-203.

[Walther 96] J. B. Walther: Computer-mediated communication: impersonal, interpersonal, and hyperpersonal interaction. *Human Communication Research, 23*(1), 3-43.

[Warkentin et al. 97] M. E. Warkentin, L. Sayeed, R. Hightower: Virtual teams versus face-to-face teams: An exploratory study of a web-based conference system. *Decision Science, 28*(4), 975-996.

[Yukelson 84] D. Yukelson, R. Weinberg, A. Jackson: A multidimensional group cohesion instrument for intercollegiate basketball teams. *Journal of sport psychology, 6*, 103-117.

[Zack 94] M. H. Zack, Electronic messaging and communication effectiveness in an ongoing work group. *Information and Management, 26*(4), 231-241.

Appendix

Appendix 1: Framework of virtual teams research (by Pinsonneault & Caya, 2005)

Personal Factors

*Personal characteristics and personality traits
*Member status
*Individual role characteristics
*Experience with technology

Situational Fators

*Reason for group membership
*Stage in group development
*Social structure/context

Group Structure

*Group size
*Work group norms
*Status/power structrue
*Group history
*Level of dispersion
(Geographical, temporal, cultural, organization)

Task Characteristics

*Nature and type
*Equivocality
*Level of interdependence

Technological Support

*Computer support and training
*Usage rules and practices
*Anonymity
*Synchronous/ asychronous technologies (media type)
*Multipicity of cues
*Immediacy of feedback

Communication and Information Exchange

*Common vs unique information
*Equality of participation

Coordination and Control Activities

*Behavioral control
*Temporal coordination
*Interaction patterns
*Coordination efficiency

Conflict and Conflict Management

*Conflict
   *Task
   *Affective
*Conflict management stragtegies
   *Avoidance
   *Confrontation
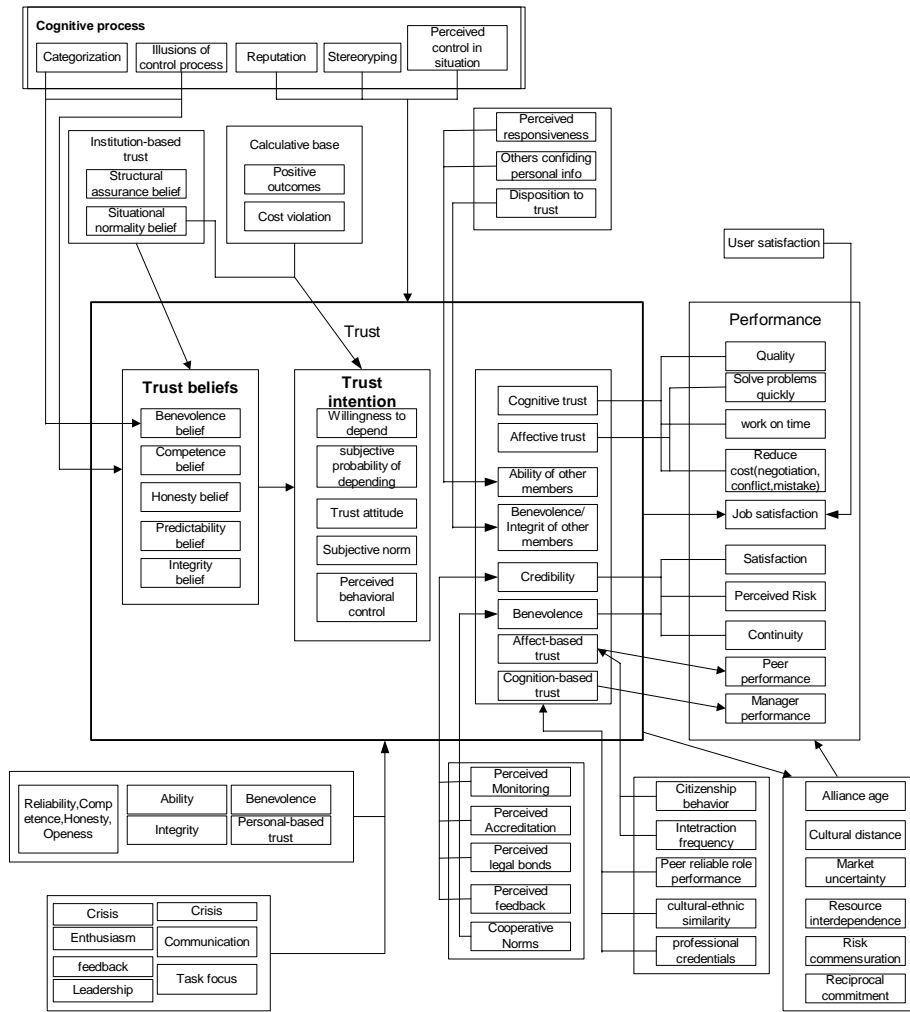   *Cooperation
   *Compromise

Interpersonal Behaviors

*Relational Links
*Socio-emotional information
*Task related information

Group Dynamics

*Cohesiveness
*Trust
*Effective leadership

Task-Related Outcomes

Characteristics of the outcomes
   *Quality
   *Time to completion
   *Productivity
Attitudes towards outcomes
   *Satisfaction with outcomes
   *Perceived performance

Group-Related Outcomes

Attitudes towards process
   *Satisfaction with process
   *Quality of the process
   *Positive feelings towards others
   *Communication and information exchange

Technology-Related Outcomes

*perceived richness
*Social presence
*Communication interface
*Satisfaction with the medium

Appendix 2: The diagram of "trust"

Appendix 3: The Measurement of Performance and Satisfaction in Virtual Teams

Year	Author	Measurement	Scale
1994	Galegher et al.	Performance: • Graders • Meeting quality • Perceived project quality Satisfaction: • Perceived fairness • Satisfaction with workgroup	 Developed by this study Developed by this study Developed by this study Developed by this study
1996	Straus	Performance: • Group and experts' rankings • Group process Satisfaction: • Satisfaction with the process • Satisfaction with the task	 Transcripts of the group discussions Straus & McGrath (1994) and O'Reilly & Roberts (1976)
1997	Straus	Performance: • Productivity • Satisfaction	Number of nonredundant ideas, questions answered, issues resolved Reflect positive and negative reaction
1997	Warkentin et al.	Performance: • Individual ranking • Information exchange effectiveness Satisfaction: • Satisfaction with group outcomes	 Hightower & Sayeed (1995,1996) Chidambarum (1996)
2001	Benbunan-Fich et al.	Performance: • Discussion record • Group report • Perception of discussion quality	 Gouran et al. (1978)
2001	Shen et al.	Performance • Perception of learning effects Satisfaction: • Satisfaction with the examination process	Not mentioned Not mentioned
2002	Dufner et al.	Performance: • Perception of problem solving ability	Dufner & Kwon (1998)
2002	Ocker	Performance: • Decision quality • Perceived level of teamwork Satisfaction: • Solution satisfaction • Solution confidence • Process satisfaction	 Gouran et al. (1978) Davison (1997) Green & Taber (1980) A six-item scale Green & Taber (1980)
2002	Valacich et al.	Performance • Decision outcomes (individual and group recommendation) • Perceptual outcomes (participation and satisfaction) • Task and group conflict	 Green & Taber (1980) Green & Taber (1980) Miranda & Bostrom (1993-1994)
2002	Tidwell et al.	Performance: • Conversational effectiveness	Canary & Spitzberg (1987)

References for "trust"

[Clases et al. 03] C. Clases, R. Bachmann, R, T.: Wehner, Studying trust in virtual organizations. *International Studies of Management & Organization, 33*(3), 7-27.

[Erdem & Ozen 03] F. Erdem, F. Ozen: Cognitive and affective dimensions of trust in developing team performance. *Team Performance Management, 9*(5/6), 131-135.

[Hoy & Tschannem-Moran 05] W. K. Hoy, M. Tschannem-Moran: *The conceptualization and measurement of faculty trust in schools: The Omnibus T-Scale*. Retrieved 8 May, 2005, from http://www.coe.ohio-state.edu/whoy/Omnibus%20T-Scale%20Paper.pdf

[Jarvenpaa & Leidner 99] S. L. Jarvenpaa, D. E. Leidner: Communication and trust in global virtual teams. *Organization Science, 10*(6), 791-815.

[Li et al. 04] X. Li, J. S. Valacich, T. J. Hess: *Predicting user trust in information systems: A Comparison of competing trust.* Paper presented at the International Conference on System Sciences, Hawaii.

[Luo 02] Y. Luo: Building trust in cross-cultural collaborations: Toward a contingency perspective. *Journal of Management, 28*(5), 669-694.

[Mayer et al. 95] R. C. Mayer, J. H. Davis, F. D. Schoorman: An integration model of organizational trust. *Academy of Management Review, 20*(3), 709-730.

[McAllister 95] D. J. McAllister: Affect- and congnition-based trust as foundations for interpersonal cooperation in organizations. *Academy of Management Journal, 38*(1), 24-59.

[McKnight et al. 98] D. H. McKnight, L. L. Cummings, N. L. Chervany: Initial trust formation in new organizational relationship. *Academy of Management Review, 23*(3), 473-490.

[McKnight et al. 02] D. H. McKnight, V. Choudhury, C. Kacmar: Developing and validating trust measures for E-Commerce: An integrative typology. *Information System Research, 13*(3), 334-359.

[Morris et al. 02] S. A. Morris, T. Marshall, R. KellyRainer: Impact of user satisfaction and trust on virtual team members. *Information Resources Management Journal, 15*(2), 22-30.

[Pavlou 02] P. A. Pavlou: Institution-based trust in interorganizational exchange relationships: The role of on line B2B marketplaces on trust formation. *Journal of Strategic Information Systems, 11*, 215-243.

[Ridings et al. 02] C. M. Ridings, D. Gefen, B. Arinze: Some antecedents and effects of trust in virtual communities. *Jorunal of Strategic Information Systems, 271-295*.

[Sarker et al. 03] S. Sarker, J. S. Valacich, S. Sarker: Virtual team trust: Instrument development and validation in an IS educational environment. *Information Resources Management Journal, 16*(2), 35-56.

[Zaheer et al. 98] A. Zaheer, B. McEvily, V. Perrone: Does trust matter? Exploring the effects of interorganizational and interpersonal trust on performance. *Organization Science, 9*(2), 141-159.