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Using an Internet-based GSS to Support Virtual Teams: An Empirical Investigation

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The studied conducted by the cluster of NJIT (e.g., Dufner et al. 1995; Fjermestad et al. 1995; Kim, Hiltz and Turoff 1998; Ocker and Fjermestad 1998; Ocker et al. 1995 & 1996 & 1997) focused more on group outcomes, rather than group development. Impacts of different communication modes (FtF, FtF GSS, distributed GSS, asynchronous GSS, and combined communication) and structures/tools of GSS on group outcomes were the main issues examined in their research. They found out that using GSS tools improved group outcomes (Dufner et al. 1995), groups with leadership performed better than those without leadership (Kim, Hiltz and Turoff 1998), and asynchronous GSS groups performed better than FtF groups in creativity (Ocker and Fjermestad 1998; Ocker et al. 1995 & 1996). Their findings suggest that to improve group performance, suitable GSS tools/structures should be used and further, more tools/structures should constructed and embedded into GSS.

In summary, a comprehensive review of GSS literature indicates that inadequate research is conducted in the area of asynchronous GSS study, and new theoretical structures should be constructed to address the important issue of speeding up group development for asynchronous GSS groups.

Based on theories of Dialogue (e.g., Bohm 1990; Schein 1993), Goal-setting (Locke and Latham 1990), Learning Organization (Senge 1990), and Alignment (Culbert and McDonough 1980), a theoretical framework for enhancing group development was proposed by Huang et al. (1998), as shown in Figure 1. There are 5 components in the framework, which is briefly described below (for detailed description, please see Huang et al. (1998).

(1)Team members have a Small-Talk to introduce themselves in terms of name, sex, individual background information, and even sharing jokes (Jarvenpaa and Knoll 1996).

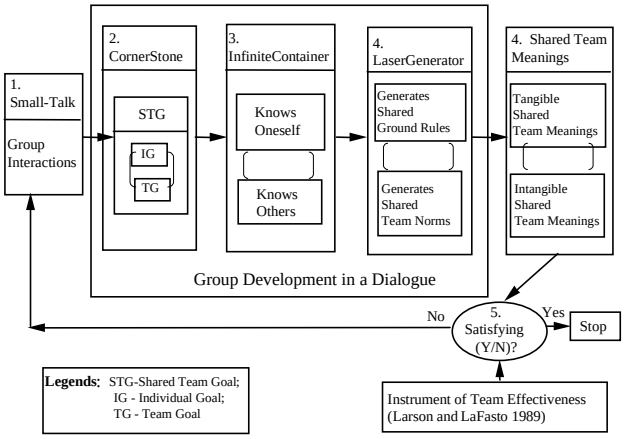

Figure 1 A Conceptual Framework for Enhancing Group Development

(2) CornerStone component. Group members have a GSS dialogue on defining and generating shared group goals. A group goal is an objective or end result that a team seeks to achieve, and toward which a team works (Johnson and Johnson 1987).

(3) InfiniteContainer component. The core of this theoretical framework is a dialogue session guided by the MIT dialogue procedure (Schein 1993):
Firstly, group members are asked to think of their past team working experiences in terms of good team communications. *Secondly*, members disclose and share their past team working experiences; identify related characteristics of their experiences in terms of good team communication protocols and team roles (Turoff et al. 1993). *Thirdly*, given the shared team goals, members exchange and clarify their thoughts towards the above-identified characteristics of good team communications. *Fourthly*, members are not allowed to criticize others' ideas and justifications to meet the requirement of the container and suspension of a dialogue. *Fifthly*, the dialogue will be closed when no further exchange and clarification from team members are required.

(4) LaserGenerator component. Outcomes of a dialogue, described as laser by Bohm (1990), can be produced. More specifically, *given the shared team goals*, team members rank the characteristics of good team communications, another round of pooled coordination activity (Turoff et al. 1993). *In other*

words, team members are asked to determine (by ranking) what characteristics of team communications are most important to the attainment of the shared team goals. This can result in specific team interaction rules shared by all members, which will guide team's future communications, interactions, and activities.

(5) The above two types of dialogue outcomes can be measured using the instrument of Larson and LaFasto (1989) to check whether or not a team achieves a satisfactory level of group development. If not, the team can repeat the dialogue procedure until a satisfactory level is achieved.

Huang et al. (1996) reported that after the component of the CornorStone was embedded into GSS structures, group social and relational links might be enhanced so that social presence of GSS was increased. Their research findings suggest that if the theoretical framework of Figure 1 is embedded into a GSS system, the GSS may be able to enhance and speed up group development even in an asynchronous group setting.

3 RESEARCH HYPOTHESES AND METHODOLOGY

3.1 Research Hypotheses

This study explores whether or not a web-based GSS embedded with the framework of Figure 1 can speed up group development. The independent variable is *GSS structure* (the presence versus absence of the group development framework in GSS). The dependent variables include three group relational variables – group cohesion (Chin, Salisbury and Gospal 1996), collaboration climate, and commitment (Larson and LaFasto 1989); and two group outcome variables – number of creative ideas (Chidambaram, Bostrom and Wynne 1991), and decision confidence (Sambamurthy 1989). Research hypotheses are thus formulated to test whether or not a GSS embedded with the framework can help speed up asynchronous group development and also improve the performance of its group work. Because FtF cannot be used to support asynchronous group work and is thus less relevant to an asynchronous group research study, the following hypotheses will be formulated only for GSS supported asynchronous groups. Further, a GSS embedded with the framework is denoted as an "EM-GSS" and a GSS without the embedded framework is denoted as a "standard GSS".

Group cohesion refers to the attraction of a group and the closeness that members feel to each other (Seashore 1954), **group commitment** refers to the "team spirit", a sense of loyalty and dedication to a team (Larson and LaFasto 1989), and **group collaboration** refers to the degree to which a team can work well together (Larson and LaFasto 1989).

For EM-GSS groups, they have specific communication ground-rules that are discussed openly by all group members in an electronic dialogue session (see Figure 1), which will guide their group interactions and group work in the future. Such ground-rules of communications are generally shared and commonly accepted by all group members. Consequently, under the guidance of such shared ground-rules, group members may feel closer to each other and the sense of group identify would be stronger even when a group just starts to work at its first formal working meeting. As a result, they are more likely to collaborate with each other and commit to the group work. Further, prior research also reported that the component of the theoretical framework might enhance group relational links and thus increased social presence in GSS groups (Huang et al. 1996). Therefore, we have:

H1 An EM-GSS will enhance the cohesion of an asynchronous group even at the first session of the group meetings, as compared to a standard GSS.

H2 An EM-GSS will enhance the commitment of an asynchronous group even at the first session of the group meetings, as compared to a standard GSS.

H3 An EM-GSS will enhance the collaboration of an asynchronous group even at the first session of the group meetings, as compared to a standard GSS.

Number of creative ideas is the total number of unique decision ideas/alternatives generated by a team (Chidambaram, Bostrom and Wynne 1991). The **decision confidence** measures the perceptions of group members on the final group decision reached (Sambamurthy 1989).

An EM-GSS may increase group cohesion even at the first session of group meetings (H1). An meta-analysis shows that a more cohesive group is generally more productive (Evans and Dion 1991), which may lead to more creative ideas as well. Further, because all decision-making processes are guided by shared group communication ground-rules in EM-GSS groups, group members are likely to feel more

comfortable and confident to the final group decision reached. Therefore, we have:

H4 An EM-GSS will increase number of creative ideas generated in an asynchronous group, as compared to a standard GSS.

H5 An EM-GSS will increase decision confidence for an asynchronous group, as compared to a standard GSS.

3.2 Research Methodology

This research adopts a 1x2 factorial design. The GSS structure is varied with the presence and absence of the theoretical framework of Figure 1. All groups (EM-GSS groups and standard GSS groups) were supported with a web-based GSS system, TCBWorks (Dennis, Pootheri and Natarajan 1997). Subjects in this study were 170 master degree students majoring in general management in two big universities located in different cities, who were taking a core information systems course. They were given course credits for participating this experiment. Group members were instructed not to discuss the experimental issues using any other communication channels except the GSS system provided. Otherwise, their marks would be decreased by up to 60%. There were 17 groups in each condition (treatment). The group size was five. Subjects were randomly assigned to the two experimental conditions. The whole experiment lasted for three weeks and all groups went through a following similar experimental procedure:

(1) In the first week, for EM-GSS groups, members were asked to generate shared group communication ground-rules according to the framework of Figure 1. For standard GSS groups, members were asked to perform a filler task. The purpose of this filler task was to equate the time for each type of teams (Hinsz 1995). Hence, the members in these two types of teams had the same time period to interact, cohere, and collaborate with each other initially. At the end of the week, a questionnaire was given to groups to fill in.

(2) In week 2, all groups performed an idea generation task: the car parking problem (Jessup, Tansik and Laase 1995). At the end of the week, a questionnaire was given to groups to fill in.

(3) For week 3, all groups performed an intellective task: university admission task (Dennis 1993). At the end of the week, a questionnaire was given to groups to fill in.

(4) Had a short post-meeting debriefing for all groups.

To address the issue of learning effects for groups to perform two tasks in a within-subject design, the sequence of performing the car parking task and university admission task was controlled – roughly half of the groups in each condition performed the car parking task first, and another half performed the university admission task first.

4 RESEARCH RESULTS

The means and standard deviations of all dependent variables are presented in Table 1.

Table 1 Means (Standard Deviations) of Dependent Variables

	EM-GSS	Standard GSS	Total
1. Team Cohesion			
Week 1	5.32 (.33)	4.86 (.35)	5.09 (.41)
Week 2	5.14 (.45)	4.72 (.88)	4.93 (.72)
Week 3	5.44 (.40)	5.02 (.48)	5.23 (.48)
2. Commitment			
Week 1	3.31 (.31)	2.96 (.27)	3.13 (.34)
Week 2	3.42 (.42)	2.98 (.30)	3.20 (.42)
Week 3	3.29 (.21)	3.14 (.40)	3.22 (.32)
3. Collaborative Climate			
Week 1	3.19 (.34)	3.10 (.30)	3.15 (.32)
Week 2	3.53 (.41)	2.99 (.34)	3.27 (.46)
Week 3	3.19 (.30)	3.15 (.38)	3.17 (.34)
4. The Number of Creative Ideas			
Week 2	10.12 (1.58)	5.29 (1.21)	7.71 (2.81)
Week 3	5.85 (1.42)	2.55 (1.42)	4.20 (2.18)
5. Decision Confidence			
Week 2	4.55 (.43)	4.33 (.67)	4.44 (.57)
Week 3	4.70 (.42)	4.70 (.68)	4.70 (.55)

Multivariate analysis of variance (MANOVA) test and paired-samples T-test were used to perform statistical analyses. A significance level of .05 was used for all tests. First, to test changes in overall group relational development over time, a repeated measures MANOVA was conducted for relational development variables across the three weeks (Chidambaram 1996); then, repeated measures MANOVAs were conducted for each of the relational development variables across the three weeks; and finally, paired-samples T-tests were conducted to detect significant differences between two specific treatment conditions (Chidambaram, Bostrom and Wynne 1991). Table 2 shows results of repeated measures MANOVA tests.

Table 2 Repeasted Measures MANOVA Test Results of Study Variables

Overall MANOVA Test Across Treatment Over Time (All Variables)					
Test Name	Value	Exact F	Hypothesis df	Error df	Sig. of F
Pillai's trace	.422	7.303	3	30	.001*
Wilk's lambda	.578				
MANOVA Test for Cohesion (Between Treatments Over Time)					
Test Name	Value	Exact F	Hypothesis df	Error df	Sig. of F
Pillai's trace	.002	.034	2	31	.002*
Wilk's lambda	.998				
MANOVA Test for Commitment (Between Treatments Over Time)					
Test Name	Value	Exact F	Hypothesis df	Error df	Sig. of F
Pillai's trace	.086	1.466	2	31	.086**
Wilk's lambda	.914				
MANOVA Test for Collaboration (Between Treatments Over Time)					
Test Name	Value	Exact F	Hypothesis df	Error df	Sig. of F
Pillai's trace	.254	5.277	2	31	.254
Wilk's lambda	.746				
MANOVA Test for Number of Creative Ideas (Between Treatments Over Time)					
Test Name	Value	Exact F	Hypothesis df	Error df	Sig. of F
Pillai's trace	.749	125.241	1	32	.000
Wilk's lambda	.204				
MANOVA Test for Decision Confidence (Between Treatments Over Time)					
Test Name	Value	Exact F	Hypothesis df	Error df	Sig. of F
Pillai's trace	.172	6.660	1	32	.015*
Wilk's lambda	.828				

* p < .05; **p< .10

As shown in Table 2, repeated measures MANOVA tests for all relational development variables, and separated MANOVA tests for the variables of cohesion, number of creative ideas, and decision confidence were significant at .05 level; the MANOVA test for the variable of commitment was significant at .10 level (p=.086); and the MANOVA test for the variable of collaboration was not significant (p=.254). Due to the exploratory nature of this study, t-tests were conducted for all variables to identify those sessions/weeks during which the degree of group relational development among groups differed between the two treatment conditions (i.e., with and without the framework).

H1, H2 and H3 hypothesized that the degree of relational development would be higher in EM-GSS groups than standard GSS groups even at the first session of their group meetings, which was supported (for cohesion, t=-3.927, p=.000; for commitment, t=-3.453, p=.002; for collaboration, t=-3.962, p=.000). Figure 2, 3, and 4 provide visual representations of profiles of the three relational development variables.

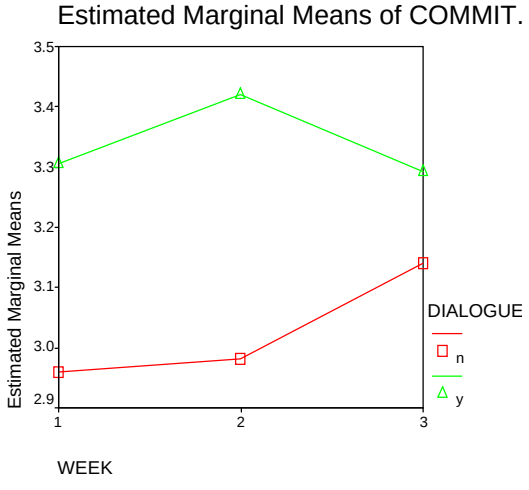

Figure 2 Visual Representation of the Profile of Commitment

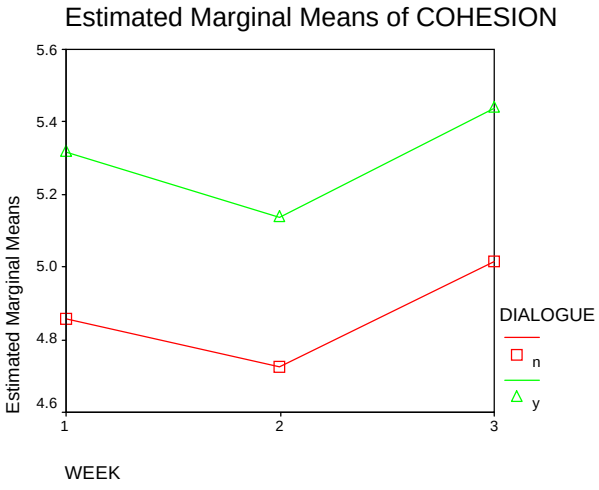

Figure 3 Visual Representation of the Profile of Cohesion

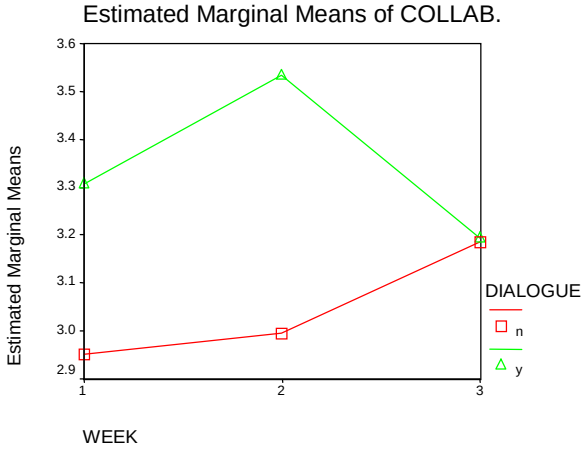

Figure 4 Visual Representation of the Profile of Collaboration

H4 and H5 hypothesized that EM-GSS groups would outperform standard GSS groups in terms of number of creative ideas, which was supported for the parking task (t=-9.999, p=.000; this dependent variable was not applicable to the task of the university admission task); and in terms of decision confidence, which was not supported for both tasks (for the parking task, t=-1.144, p=.261; for the university admission task, t=-.013, p=.990). Figure 5 and 6 provide visual representations of profiles of the two outcome variables.

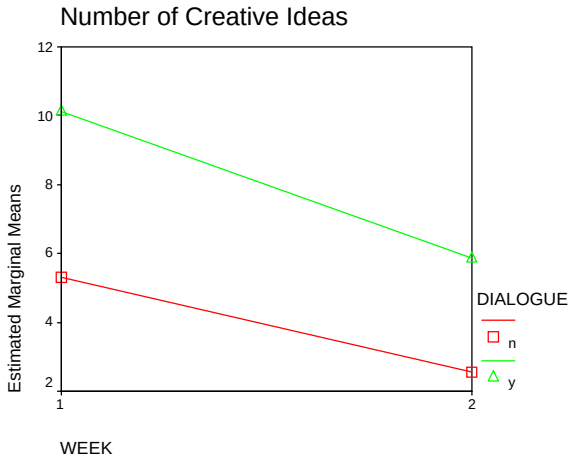

Figure 5 Visual Representation of the Profile of Number of Creative Ideas

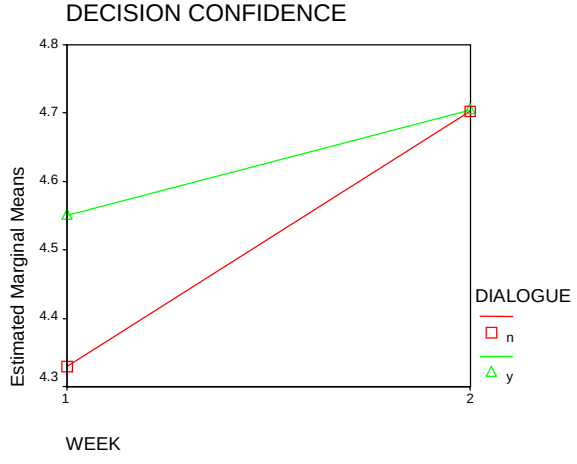

Figure 6 Visual Representation of the Profile of Decision Confidence

Further, post-hoc analyses showed that at the week 2, there was no difference in the degree of cohesion between EM-GSS and standard GSS groups (t=-1.716, p=.096). At the week 3, no differences in group commitment and collaboration were found between the two types of groups (for group commitment, t=-1.386, p=.175; for group collaboration, t=-.060, p=.953). This indicates that even though at the beginning, EM-GSS groups developed relational links faster than standard GSS groups. Starting from the week 2, standard GSS groups could gradually develop relational links, and at the week 3, difference in group relational development between the two types of groups was largely narrowed down and not significant any more.

5 DISCUSSION AND IMPLICATIONS

This longitudinal study reported that *firstly*, with the theoretical framework, GSS could help groups develop relational links faster even at the first session of group meetings in an asynchronous group working environment (H1, H2, and H3 were all supported). *Secondly*, without the framework, GSS could still support groups to develop relational links, but it took a longer time. The group developmental pattern was that starting from the second session, standard GSS groups narrowed their gap with EM-GSS groups in relational development, and in the third session, such gap was largely filled (supported by the post-hoc tests). This pattern of group relational development for GSS groups is generally in line with prior research findings (e.g., Chidambaram 1996; Walther 1995). *Thirdly*, EM-GSS groups generated more creative ideas when performing an idea generation task (H4 supported), but no difference was found in decision confidence between EM-GSS and standard GSS groups (H5 not supported).

Some prior studied reported that initially, GSS even decreased group relational development (e.g., Chidambaram 1996; Warkentin, Sayeed and Hightower 1997); and as time went on, the GSS groups could gradually associate socially (e.g., Chidambaram, Bostrom and Wynne 1991; Walther 1995). Our research results suggest that GSS' detrimental to group relational development at the beginning of group work, as reported by the prior GSS research, is not the inherent feature of a GSS system itself. With a suitable theoretical framework or structure embedded into a GSS, the GSS can actually enhance group relational development at the first session of group meetings, even in an asynchronous group working environment. As a result, a good news to organizations is that the efficiency problem of using GSS to support distributed and/or asynchronous group work may not be the key issue they need to consider, and the key issue may be the choice of suitable GSS structures/tools to support group development.

Further, standard GSS groups generated significant less creative ideas than EM-GSS groups (H4 supported). This may suggest that without shared communication ground-rules generated with the guidance of the theoretical framework, GSS groups might be distracted from their group work by spending some group time in resolving possible disagreement and/or even conflicts among group members, especially at group developmental stages of forming, storming and norming (e.g., McGrath 1990; Tuckman 1965). As a result, less creative ideas were produced by the standard GSS groups.

In general, there are two types of research approaches (Ackoff, Gupta and Minas 1962; Nunamaker et al. 1991): *developmental and empirical research*. The former attempts to develop improved work methods whereas the latter evaluates and understands them. Our current research findings indicate that with a suitable theoretical framework constructed and embedded into a GSS, the GSS can support and speed up group development in an asynchronous group environment. While there are still many research issues unresolved in GSS field (Briggs, Nunamaker and Sprague 1998) and most prior GSS research is empirical in nature, more research is thus needed in the future to adapt existed, and/or develop new, group work methods (Nunamaker et al. 1991; Olson et al. 1993) that can be embedded into GSS. In this way, GSS can be used to better meet organizational needs for various tasks and in different contexts.

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