The Impacts of Delphi Communication Structure on Small and Medium Sized Asynchronous Groups: Preliminary Results

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Abstract

Communication structure is a way of improving the effectiveness of group communications by coordinating group members' individual efforts. This study investigates the use of Delphi, a communication structure which has been widely used to collect ideas and opinions from geographically dispersed experts. A new approach in Delphi implementation using asynchronous Computer-Mediated Communication (CMC) is developed. A 2X2 controlled experiment investigates the effect of Delphi structure on small-sized (5-6 members) and medium-sized (10-12 members) asynchronous CMC groups. The group task is to describe the potential applications and impacts of pervasive devices that can track the location of individuals. Preliminary results indicate that the Delphi structure does result in more unique ideas per person than the unstructured condition.

1. Introduction

Computer-Mediated Communications (CMC) consists of two important ingredients—computer and communications. CMC's main objective is the use of *computer technology* in order to increase the effectiveness of *group communications*. Previous CMC research mainly focused on the effect of "computer technology" by comparing CMC groups with face-to-face groups and not much attention was given to "group communication structuring" (Fjermestad and Hiltz, 1998-1999). But the more fundamental question is "Why group?" rather than "Why technology?" The possible role of "computer technology" in designing CMC should focus on maximizing the benefits of group processes. Does CMC help groups achieve their true potential? Some research reported discouraging findings; CMC groups do not always perform better than individuals working alone [21, 30] and computer-supported groups do not outperform their best members [12]. What can be done to improve this situation?

Through asynchronous CMC, temporarily and geographically dispersed groups could collaborate more flexibly because group members could make contributions at any time and place. Previous research showed that asynchronous CMC has advantages in generating more creative ideas [27], in inferring ideas from stated facts [37], and in making more effective decisions in new product development [36], compared to face-to-face communications. However, previous research on asynchronous CMC communications reported many problems such as long time lags between question and reply, "dropout" or "latency" problems, and the "multi-headed animal syndrome." These problems might be due to lack of sharing of the utterance time and place in asynchronous environments [18]. Imposing a communication structure (often accompanied with human facilitation) could alleviate these problems in asynchronous CMC. Hiltz et al. (1996) suggest that there are two different approaches in designing CMC: a highly structured (restrictive) approach and unstructured (less restrictive) approach. Studies on the effect of different types of facilitation (or intervention) in synchronous CMC [10, 14, 18, 22, 31] found that having a form of facilitation or intervention helps groups accomplish better outcomes. Overall, less restrictive approaches seem to work better in the synchronous CMC environment [10, 14], but there were not many studies investigating this issue in asynchronous CMC environment.

Group process differs from individual process mainly because it needs communication and coordination efforts [24, 41]. As group size increases, more coordination effort is needed. A large face-to-face group has to follow a highly structured process (such as a parliamentary meeting using Robert's Rules of Order) for a smooth communication process. As group size increases, asynchronous dispersed group members might have more difficulties in coordinating the work and highly structured approaches might be needed in order to synchronize the group members' efforts [19]. In their review of five experiments conducted at New Jersey Institute of

Technology, Hiltz et al. (1996) reported that structured approaches had no significant effect on group outcomes in asynchronous CMC environments and this result is quite different from the one in synchronous CMC environments. However the authors noted that some of their experiments did not have strong manipulations or the task used was not complex enough or the groups were not large enough to receive benefit from structuring. These issues have to be considered in future research.

Considering the above facts, some kind of communication structuring (including a form of facilitation) would be desirable to make asynchronous CMC more effective. "Structuring" restricts or channels communications with specific procedures. Among the many communication structuring methods designed to enhance group productivity are brainstorming [28], Nominal Group Technique (NGT) [46] and the Delphi Method [23]. NGT is a method of idea generation and evaluation for face-to-face meetings. In NGT, members generate ideas individually and evaluate those ideas through voting. NGT contrasts to brainstorming technique which emphasizes interactive idea generation without evaluation. Delphi was chosen in this research since it is a widely used method to facilitate geographically and temporally dispersed discussion groups of medium to large size.

The Delphi method has been used in various application areas to share opinions and ideas about complex or ill-defined issues among experts who are possibly geographically dispersed [23]. Traditional paper-and-pencil Delphi uses a series of mailed questionnaires with feedback of the results of the "rounds" as a communication medium. The original purpose of Delphi was to structure group discussions to facilitate a large number of individuals communicating without experiencing severe process losses. However, in practice the high operating cost and lack of standards kept the Delphi structure from being utilized for this original purpose. Those difficulties in its implementation led to the lack of validity of the empirical studies on the effect of the Delphi structure [32, 34].

In this study, a computer-based Delphi structure was implemented through asynchronous CMC. It is believed that the computer-based implementation will make it possible to utilize the Delphi structure as an effective means of structuring medium to large size, dispersed asynchronous group discussions. The overall research objective is to examine the separate and joint effects of group size and Delphi structure on the process and outcome of task-oriented asynchronous CMC groups.

2. Literature Review

2.1. Group Size

Group research started from the basic belief in the "N+1 heads are better than one" principle. One line of this research is comparing individual and group performances [4, 3, 16, 26, 49] and the general tendency of the findings is that groups do not always perform better than individuals working alone, in terms of both the accuracy of their decisions and the number of ideas generated. The other line of research is investigating the optimal group size; overcrowded face-to-face groups do not satisfy members with their decision-making process [15].

Most investigations of the effect of different group sizes in CMC involved computer brainstorming using idea generation tasks. Most of the research used group size and technology (electronic brainstorming vs. verbal brainstorming) as independent variables and effectiveness (i.e., the number of unique ideas, the quality of ideas) and perceived effectiveness (satisfaction, perceived process gains and process losses) as main dependent variables [1, 7, 8, 6, 13, 43, 44]. In general, the findings suggest that (1) large groups benefit more from computer technology than small groups, (2) diversity of knowledge of group members—rather than the group size itself—increases group performance.

However, previous CMC research does not provide conclusive evidence of advantages of group processes over individual processes. Based on Pinsonneault et al.'s review (1999) of five studies comparing electronic brainstorming groups to nominal (or pooled) groups, electronic brainstorming was found to be superior to nominal idea generation for large (larger than nine) groups only. Moreover, there are not many studies investigating the effect of CMC in terms of per person performance—which would be a more accurate group performance measure. Most of the previous research on group size confounded the effects of technology (electronic vs. non-electronic) and structure (individual process vs. brainstorming); future research should investigate which specific aspects of technology make "group process" work.

2.2. Group Communication Structure (Delphi Structures)

What can be done to make groups perform better than individuals in decision making? How can members of a large asynchronous group communicate and make better decisions without breaking down from process losses? Communications distinguish group processes from individual processes and group communications introduce factors that enhance performance (i.e. process gains) and factors that inhibit performance (i.e. process losses). The potential role of CMC for improving group decision-making is to maximize process gains and minimize process losses.

Delphi [5, 23] is a communication structure for asynchronous dispersed groups, usually large (15 to 300 individuals), through written modes. Delphi typically deals with ill-defined or complex tasks involving many different task types from McGrath's task circumplex, rather than involving a specific subtask [23]. Delphi has been used in various applications, including forecast of exports / imports in specific industries [23]; forecast of future sales trends of a product and development of consequences of actions by other competitors [23]; evaluation of policy issues [38]; identification of political events and analysis of the risk associated with these events [2]; identification of software project risks [36]; and development of an explanation facility in a knowledge-based system [9].

In traditional paper-and-pencil based Delphi, a human facilitator organizes opinions or judgments contributed from geographically and temporally dispersed experts through multiple rounds of carefully designed questionnaires, and feeds back a summary of the views for each round. The initial phase of Delphi processes is for exploring a specific problem domain and it usually involves extensive literature reviews or surveys. After the participants are well-informed on the problem domain, they are asked to generate a list of similar items as useful inputs to solve the given problem. Through a series of voting iterations, they evaluate the list of items generated and explore reasons for disagreements. The final goal of this process is to seek either consensus or explanation of disagreements.

As a communication structure, Delphi has two characteristics [40]: (1) feedback of summarized views of other members is presented to the group members, who are then given a chance to change their earlier opinions or judgments; and (2) anonymity is often used to avoid social pressures. The feedback-revision process is the heart of Delphi processes.

In computer-based versions of Delphi [39, 40], asynchronous CMC is used as a delivery medium instead of mailed questionnaires. As a result, the round structure of paper-and-pencil based Delphi is changed into continuous asynchronous contributions and the resulting materials, organized with a minimum level of human intervention [39]. The required structures such as nominal contribution and controlled feedback are enforced by human facilitation in paper-and-pencil based Delphi, while special software features for automated facilitation can be used in computerized Delphi. Table 1 summarizes the most important dimensions of the structures that have been discussed [19].

Table 1. Comparison of different group communication systems

	Communication Medium	Communication Mode	Facilitation Mode	Computer Support	Coordination Mode	Task Complexity	Group Size
Face-To-Face Groups	Face-to-Face	Verbal	Highly Variable	No	Sequential	Low	Small
Synchronous (Decision Room) GDSS	Face-To-Face	Verbal + Written	(possible) Human Facilitation	Yes	Sequential	Low	Small to Medium
Asynchronous CMC	Dispersed	Written	(possible) Human Facilitation	Yes	Parallel or Pooled	Medium	Medium to Large
Nominal Group Technique	Face-To-Face	Verbal + Written	Human Facilitation	No	Pooled	Medium	Small to Medium
Paper-and-Pencil Delphi	Dispersed	Written	Indirect Human Facilitation	No	Reciprocal	High	Medium to Large
Computerized Delphi	Dispersed	Written	Human + Computer Facilitation	Yes	Reciprocal	High	Medium to Very Large

The Delphi method has been criticized [34] due to the lack of evidence of its superiority over other structures or unstructured discussions. Rowe and Wright (1999) reviewed 27 published studies involving evaluation of the Delphi technique and found no consistent results. However, the Delphi method consists of many different factors (different types of anonymity / feedback /voting /iteration /tasks) and there is no standard procedure or implementation. Therefore, inconsistent results are to be expected. Previous Delphi research focused on technique comparison—such as comparison of Delphi with NGT, or Delphi with face-to-face meetings. However, in future Delphi research, more effort should be devoted to investigate which factors of Delphi make this method more effective.

3. Research Questions and Framework

In order to achieve benefits from group communication, process gains should outweigh process losses in the group process and/or group communication technology. To achieve this objective, group communication should facilitate individual information processing, rather than inhibiting it. Computer-based Delphi was designed under this principle; individuals are able to concentrate on their own thinking process when necessary, and group communication is done through controlled feedback to reduce process losses and enhance process gains.

Since asynchronous CMC differs vastly from its synchronous counterpart, there might be different effects of process gains and process losses. If there are different effects on process gains and process losses in the asynchronous environment, group size might also have different impacts and these issues are fundamental to understanding the nature of asynchronous CMC. However, to date, there is no study investigating these issues in asynchronous CMC.

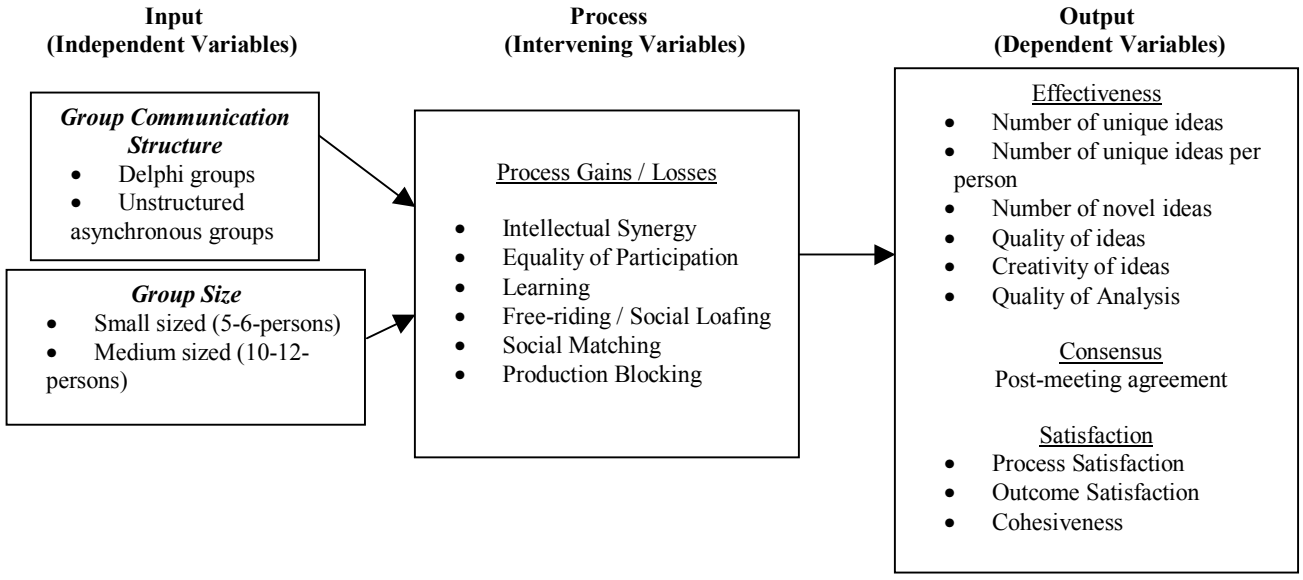
Previous Delphi research mainly focused on the question of "Does Delphi work?" However, not much research addressed the issue of "Why or how does Delphi work?" There was a lack of Delphi research investigating the effect of Delphi as a group communication structure—in particular the effect on group process gains and losses.

Based on the foregoing, our research project investigates the following research questions:

- How do communication structures (such as Delphi) affect asynchronous group communications?
- Does group size influence effectiveness, consensus and satisfaction with asynchronous group communications?
- How do factors of process gains and process losses intervene to produce the effects of communication structure and group size in the context of asynchronous group communications?
- What interaction effects occur between communication structure and group size?

Specifically, this paper reports the preliminary results of a controlled experiment conducted as a part of the above research project designed to investigate the effect of Delphi structure on small and medium sized groups using asynchronous group communications. Figure 1 represents the conceptual framework of our research project.

Figure 1. Conceptual framework of the research project



4. Hypotheses

Three sets of hypotheses correspond to the three sets of dependent variables in the above framework: Effectiveness, Consensus and Satisfaction; only the first set (Effectiveness) is discussed in this paper.

To date, there is only one Delphi experiment specifically investigating the effectiveness of the Delphi structure for an idea generation task: Van de Ven and Delbeq (1974) found that Delphi groups generated more unique ideas than non-structured interacting groups but did not differ significantly in terms of satisfaction. In their review paper, Van de Ven and Delbecq (1971) stated that based on three measures of performance (the number of unique ideas per person, the mean total number of ideas, and the quality of ideas produced), nominal groups (groups wherein each group member generates ideas alone without interacting with other members) have been found significantly superior to interacting groups. Even in Electronic Brainstorming Systems (EBS) research, individuals working alone have been found as productive (i.e. in terms of number of unique ideas) as EBS groups wherein group members interact each other [21, 30].

Nominal contributions without evaluation in the early phase of idea generation and controlled feedback in Delphi groups should produce more unique ideas than the free-formed contributions in unstructured asynchronous groups because group members are more likely to commit to the search process due to the silent generation of ideas—the evidence of search activity [45]. This silent idea generation phase would allow group members to reflect fully on the problem without interference. This process allows individuals to search all possible alternatives fully. Previous research [29, 33] on free-riding, social loafing and social matching showed that constant feedback could harm the effectiveness of the group by setting a lower norm of performance in the early stage of group process. It is therefore more effective to provide group feedback after each individual fully considers and searches his/her own alternatives. Especially in an asynchronous communication mode wherein contribution and feedback are dispersed in time, imposing such a structure should help groups to coordinate their efforts more effectively. Therefore, it is expected that Delphi groups are likely to perform better in terms of quantity and quality than unstructured asynchronous groups. This leads to:

H1a. Delphi groups will produce more unique ideas than unstructured asynchronous groups.

H1b. Delphi groups will produce more unique ideas per person than unstructured asynchronous groups.

Previous GSS studies showed the relative superiority of large groups in terms of the number of unique ideas produced compared to small groups [1, 7, 8, 6, 13, 43, 44]. However, most previous GSS research on group size did not investigate the effects of group size in terms of number of ideas per person. Dennis and Valacich's experiment (1993) is the only one which reported this effect but they also did not find main effects of group size on per person performance. Even though previous research did not find clear main effects of group size on per person performance, it is speculated that small groups will produce more unique ideas per person than large groups, based on the assumption that a large group would have a higher level of free-riding / social loafing. This leads to:

H2a. Medium-sized groups will produce more unique ideas than small-sized groups.

H2b. Small-sized groups will produce more unique ideas per person than medium-sized groups.

Dennis and Valacich's experiment (1993) found an interaction effect between group size and technology: Large (12 members) groups had more benefits of computer support than small (6 members) groups, in terms of per person ideas. From this finding, we may expect an interaction effect between imposing a structure[1] and group size for per person performance. Van de Ven and Delbecq (1971) also stated that as group size increases, the superiority of structured groups such as Delphi or NGT groups over unstructured groups increases in terms of total number of unique ideas and the quality of ideas produced, because structured group processes can accommodate large numbers of participants. Group size is expected to interact with Delphi structure because without any structure, it is likely that medium-sized asynchronous groups (which need more coordination efforts) will suffer disproportionately from coordination problems and process losses than small-sized counterparts. This leads to:

H3a. Communication structure interacts with group size in a synergetic manner so that medium-sized Delphi groups produce disproportionately more unique ideas than small-sized Delphi groups.

H3b. Communication structure interacts with group size in a synergetic manner so that medium-sized Delphi groups produce disproportionately more unique ideas per person than small-sized Delphi groups.

5. Research Methodology

5.1. Task

The Special Technology Inc. task was specifically designed for this study. A hypothetical case of a computer chip manufacturing company which has just developed an object tracking device is given to all groups. Groups are required to generate as many ideas of possible applications of such a device as possible, develop positive and negative

[1] In Dennis and Valacich (1993)'s study, a technology structure (not a communication structure) was used. However, we can assume that technology will impose a kind of structure to group communication.

consequences for each application generated and evaluate each application idea in terms of the level (3 point-scale) of potential impacts the consequences of the application may have in U.S. society. This task corresponds to the combination of a creativity task (Type 2 in McGrath's Task circumplex) and a decision-making task (Type 4) [25]. More importantly, it is an example of a complex social policy issue for which more public involvement could be obtained with appropriate structures for large groups of people to participate in what might be termed a "social decision support system" [42]. The task was tested and revised based on the subjects' responses to the task questionnaire distributed in the pilot studies.

5.2. Experiment Design

In order to test the hypotheses, a controlled experiment with a 2 (group size) X 2 (communication structure) factorial design was conducted. In the dimension of group size, Small-sized groups (5-6 members per group) were compared to medium-sized groups (10-12 members). In the dimension of communication structure, Delphi groups were compared to unstructured asynchronous groups. In order to obtain sufficient power, 10 groups per condition will be run. Size of six for small groups was chosen considering the high dropout rates in asynchronous CMC experiments. Because of the long time period (two-and-half weeks of experiment) and limited number of potential subjects who could be used in one semester, the cutoff points for group size (6 vs. 12 members) were chosen in order both to be compatible with Electronic Brainstorming studies investigating the effect of group size [13, 6] and to be practical in terms of obtaining sufficient subjects. Any small-sized group in which more than one member and any medium-sized group in which more than two members dropped out from the experiment was discarded from data analysis. It is not avoidable to have a buffer of group size considering high drop out rates in asynchronous CMC experiments [20].

The other independent variable of this study is communication structure. Delphi groups were compared with unstructured asynchronous groups and both groups used asynchronous CMC as their communication medium.

5.3. Subjects

The above experiment design requires 360 subjects. Subjects were recruited from undergraduate (junior and senior) level courses in the Computer Science and Information Science departments at New Jersey Institute of Technology. Students were given an option of participating in this experiment for an assignment for their courses or doing an alternative assignment. Students who decided to participate were instructed to read the on-line tutorial on Webboard system use and finished four training exercises. Through this training, students in all groups were exposed to the concept of posting ideas or comments, replying to other persons and posting in a moderated conference. After finishing the training exercises, students were assigned to a group. Two factors were expected to affect the experiment result: native language and gender. In order to avoid this effect, a stratified random sampling technique was used to mix all groups by these two factors. Each student was given a unique pen-name (login name) and password for accessing the experiment discussion board assigned to the group. This pen-name consists of two parts—group ID and the serial number in the group.

5.4. Technology used

Webboard, a Web-based asynchronous group communication system, was used in this study. In this system, a discussion board was given to a group and each board could have different conferences. Before the task was posted in the conference, group members were instructed to log into the discussion board and select a group coordinator. The group coordinator was responsible for distributing the workload of writing a group report to every member and ensuring that the group report was submitted on Webboard by the end of the experiment period. The experiment took two and a half weeks. Group members were instructed to finish the task and post their group report by the last day of the experiment. After filling out the task questionnaire and the post-experiment questionnaire, all subjects were instructed to log into a debriefing board and read the debriefing material.

5.4.1. Delphi Groups

Different Delphi implementations (such as ranking type voting and Likert scale type voting) were pilot tested through two sets of pilot studies. Structure and procedures were modified accordingly. Table 2 explains the implementation of Delphi structure which was used in this study, compared with traditional paper-and-pencil Delphi.

5.4.2. Unstructured Asynchronous Groups

Members in unstructured asynchronous groups complete the task without the Delphi structure in Table 2. However, since the anonymity effect has been shown significant in previous CMC studies, this effect was controlled in our study by providing pen-names to members in both the Delphi and the unstructured conditions. Subjects generated, discussed and evaluated ideas in one conference and that conference was not moderated—that is, they were able to see ideas and comments posted by other members any time.

Table 2. Paper-and-Pencil Delphi vs. Computerized Delphi implemented in this study

	Paper-and-Pencil Delphi	Delphi structure in this study
Anonymity	Anonymous contributions	Pen-name is used in this study
Facilitator	*Human Facilitator* designs the procedure and questionnaire / organizes the list of items / summarizes responses and feeds those responses back to the participants.	*Human Facilitator* designs the procedure and instructions / aggregates responses *Automated Facilitation*: such as moderation functions which support Nominal Idea Generation / Group Feedback / Controlled Discussion In this study a combination of human and automated facilitation is used.
Delivery (Asynchronous Communication Medium)	Facilitator designs and mails *questionnaires* to participants	A combination of an asynchronous CMC (Webboard) and survey software (SurveyTracker) is used. Facilitator posts a sequence of instructions in the conference in Webboard and also provides the URL of on-line surveys for voting.
Nominal Idea Generation	Participants fill out the questionnaire and mail it back to the facilitator.	Participants post ideas in a moderated asynchronous conference.
Group Feedback	Facilitator summarizes and mails participants' responses with the subsequent questionnaire	Facilitator approves and reveals the list of items generated by group members. Facilitator generates a report of voting results using Survey Tracker and posts the URL of the report in the Webboard.
Controlled Discussion	Participants fill out and mail the questionnaire (comments on each item and/or voting)	Participants comment on others' ideas in a Webboard conference and also provide the reasons / comments on voting in on-line voting surveys.
Iteration	The subsequent questionnaire is distributed to participants together with a summarized report of the previous round. Participants are given opportunities to change their judgments, based on the group view.	A sequence of instructions is posted in a conference. Two rounds of voting are used.

5.5. Measures of Dependent Variables (Number of Unique Ideas)

Unique ideas generated by each group were identified by the first author of this paper from the total list of ideas—including duplications removed from the list by the facilitator in Delphi groups. The number of unique ideas was divided by the number of members who actually participated in the group discussion, to calculate the number of unique ideas per person.

6. Preliminary Results

To date, data from 26 groups (6-7 per condition) were collected and analyzed. Analysis of variance (ANOVA) was used to test the hypotheses. Table 3, 4 and 5 show the preliminary results analyzed with the 26 groups run so far. In analyzing the number of unique ideas, it was found that Delphi groups generated significantly more unique ideas than unstructured asynchronous groups ($p=0.0002$) and medium-sized groups generated significantly more unique ideas than small-sized groups ($p=0.0002$). In analyzing the number of ideas per person, a main effect on the dimension of structure was also found; Delphi groups generated significantly more unique ideas per person than unstructured asynchronous groups ($p=0.0001$). Small-sized groups generated more unique ideas per person than medium-sized groups, but not significantly so ($p=0.1041$). However, no significant interaction between group size and structure was found in terms of either the number of unique ideas or the number of unique ideas per person.

7. Discussion

In general, this preliminary result shows the structured approach using the Delphi structure is more effective than the unstructured approach, in generating unique ideas by asynchronous CMC groups. It is argued that the silent idea generation phase of the Delphi structure might have made

group members to commit more to searching alternatives. In general, this result is consistent with the findings of Van de Ven and Delbeq (1971, 1974) and the previous EBS studies, which showed the superiority of a structured approach in idea generation tasks, but could have different interpretations. Since the same amount of discussion time and the same communication medium (asynchronous CMC) were given to both the Delphi and the unstructured groups in our study, it is inferred that the significant difference in the number of unique ideas have only come from the difference in the communication structuring approaches.

Table 3. Number of unique ideas

mean (standard deviation)

	Delphi	Unstructured	Total
Small-sized	13.50 (2.43)	8.42 (3.05)	10.77 (3.75)
Medium-sized	23.57 (6.65)	13.50 (3.02)	18.92 (7.30)
Total	18.92 (7.20)	10.77 (3.92)	14.85 (7.04)

Table 4. Number of unique ideas per person

mean (standard deviation)

	Delphi	Unstructured	Total
Small-sized	2.32 (0.43)	1.47 (0.52)	1.86 (0.64)
Medium-sized	2.01 (0.57)	1.16 (0.21)	1.62 (0.61)
Total	2.16 (0.51)	1.33 (0.42)	1.74 (0.62)

Table 5. Results of ANOVA

Dependent Variables	Hypotheses	Mean Square Error	(F, df)	Significance Level	Preliminary Conclusion
Number of unique ideas	H1a** (structure)	370.42	(20.56, 1)	0.0002	Supported
	H2a** (group size)	370.42	(20.56, 1)	0.0002	Supported
	H3a (interaction)	40.38	(2.24, 1)	0.1486	Not supported
Number of unique ideas per person	H1b** (structure)	4.67	(21.99, 1)	0.0001	Supported
	H2b (group size)	0.61	(2.88, 1)	0.1041	Not supported
	H3b (interaction)	0.00	(0.00, 1)	0.9965	Not supported

** p=.01

This effect of the structured approach in idea generation tasks is not conclusive in the study of Van de Ven and Delbeq (1971, 1974) or the previous EBS studies because of the uncontrolled factors of the communication medium (in case of both the EBS studies and Van de Ven and Delbecq's study) or the discussion time (in case of Van de Ven and Delbecq's study).

8. Limitations and Future Analyses

The results for group size show a similar pattern as the general finding of the previous EBS studies investigating the effect of the group size: medium-sized (10-12 members) groups generated more unique ideas than small-sized (5-6 members) groups. The effect of the group size on per person performance is not significant (p=1041), even though the resulting direction of the average number is consistent with the authors' prediction that small-sized groups (1.86) generated more unique ideas per person than medium-sized groups (1.62). However, the effects of the Delphi structure did not significantly differ in different sized groups and this contrasts to the results of the EBS studies which show a strong interaction effect between the group size and the technology-supported structure (EBS). Two possible explanations are suggested on this discrepancy; First, it might be the effect of computer technology, rather than communication structure, which enables larger groups to communicate more effectively than smaller groups. This explanation is consistent with the finding of Hymes and Olson's (1992) study which shows that even a very primitive technology enabling parallel inputs could enhance the effectiveness of group idea generation and also with the finding from the review of Pinsonneault et al. (1999) that an individual process is as effective as brainstorming process in idea generation. A second possible explanation is that the size of the medium-sized groups (10-12 members per group) is not large enough to get the full benefits of the Delphi structure.

Considering the real benefit of using Delphi structure in organizing large sized groups, it would have been preferable to run 20 very large groups (size 50 or more) but this is simply not practical in terms of available subjects. However, it is planned to conduct at least one

very large group to see how the Delphi structure devised by the authors works on a larger scale.

As with all controlled experiments using students, the generalizability of results to "real" groups doing "real" tasks is somewhat in question. However, the policy analysis task for the groups in the study was "real" in the sense that it closely related to the course topics they were studying. The student subjects received a substantial part of their course grade, based on the quality and regularity of their participation. Thus, they were motivated to put their best efforts, even though it was a laboratory task. Moreover, analysis of the background questionnaires showed that 70% of the student subjects have been employed full-time in industry. Thus, they do have some "real world" experience.

Thus far the authors have investigated only at the number of ideas during the idea generation phase. It is also necessary to examine the quality and creativity of these ideas; the quantity and quality of group ideas in the "idea evaluation" phase of the task; the post-meeting agreement; and the subjective satisfaction of the participants. In addition, it is necessary to examine how the Delphi vs. no structure conditions are related to the process gains and losses hypothesized in the model. This will give us a more complete basis for conclusions about the relative strengths and weaknesses of Delphi vs. unstructured processes in different sized asynchronous computer-mediated groups.

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