The Impacts of Media Symbol Variety on Performance in Virtual Teams

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Abstract

The purpose of this study is to examine the impacts of media symbol variety on group performance in virtual teams. Symbol variety is defined as the number of ways in which information can be communicated and includes Daft and Lengel [1986]'s multiplicity of cues and language variety. According to media richness theory and media synchronicity theory, the use of media with high symbol variety is assumed to facilitate and promote communications among virtual team members. Therefore, it is expected that the media symbol variety is positively associated with group performance in virtual teams. Furthermore, online relationship building is expected to mediate the impacts of symbol variety on the performance. To confirm the suppositions, a controlled lab experiment was conducted with 60 undergraduate students as subjects. In the experimental virtual teams, subjects were allowed to communicate with other members using text-based messenger with emoticons. Subjects in the control virtual teams were allowed to communicate using only text-based messenger. The direct impact of symbol variety on group performance in virtual teams was found insignificant. However, the online relationship was found to completely mediate the positive impact of symbol variety on group performance. The implications and limitations of this study are also discussed for future research.

Keywords : Computer-mediated Communication, Emoticons, Symbol Variety, Online Relationship, Media Richness Theory, Media Synchronicity Theory

1. Introduction

A virtual team is a group of individuals who work across time, space, and organizational boundaries with electronic links supported by communication technology. The use of virtual teams is so common in organizations today. Virtual teams are used in a variety of areas such as R&D, customer service, software development, and product design [Wakefield et al., 2008]. Although organizations increasingly rely on virtual teams in the wide range of areas, some key questions are not decisively answered. For instance, are virtual teams as productive as collocated teams? Does the use of different media (i.e., electronic links) affect group performance in virtual teams? To answer the second question, a controlled lab experiment was conducted using undergraduate students as subjects.

Media richness theory (MRT) proposes that media vary in their ability to enable users to communicate and change understanding, which is considered as media richness [Daft and Lengel, 1986]. Richer media are those with a greater language variety (the ability to convey natural language rather than just numeric information), a greater multiplicity of cues (the number of ways in which information can be communicated such as the tone of voice), a greater personalization (ability to personalize the message), and more rapid feedback [Dennis and Valacich, 1999]. Daft and Lengel [1869] argue that media capable of sending rich information are better suited to equivocal tasks, while those that are less rich are best suited to tasks of uncertainty. Most tests of media richness theory have exa-

mined perceptions of media fit [Dennis and Kinney, 1998]. Thus, managers were asked to choose a medium to send a set of hypothetical messages to determine whether their choices fit the predictions of media richness theory [Daft et al., 1987]. However, the theory was not well supported or at best partially supported [Dennis and Kinney, 1998].

To extend the media richness theory, therefore, Dennis and Valacich [1999] proposed a theory of media synchronicity. The theory argues that communication effectiveness is influenced by matching the media characteristics to the needs of the fundamental communication processes, not the aggregate collections of these processes such as tasks, as proposed by media richness theory. Dennis and Valacich [1999; 2008] present a set of media characteristics that are important in understanding the effects of media use on the ability to communicate and process information : Immediacy of feedback, symbol variety, parallelism, rehearsability, and reprocessability. Immediacy of feedback is the ability of the medium to enable rapid bidirectional communication. Symbol variety means the capability of the medium to transmit and provide information in various formats (e.g., verbal, nonverbal, visual, auditory, graphical, etc.). Parallelism refers to the number of simultaneous conversations the medium allows. Rehearsability is the extent to which the medium allows the sender to rehearse, fine-tune, or carefully edit the message before sending. Reprocessability is the extent to which a message can be examined or processed later and again during communication [Dennis and Valacich, 2008;

Munzer and Holmer, 2009]

Given the paucity of previous studies on the effects of media characteristics described in the media synchronicity theory,[1] this paper aims to examine the impacts of one of the five media characteristics, symbol variety, on the group performance in virtual teams. Hence, this paper presumes that the use of high symbol variety media in virtual teams would increase group performance. In this paper, the symbol variety is assumed to influence online relationships between members in virtual teams and then improve their group performance.

2. Literature Review

2.1 Symbol Variety

Symbol is the essence of communication and language [Dennis and Valacich, 1999]. Symbol variety has the propensity to be related with media richness. According to media richness theory, the media richness is influenced by four factors such as the ability of the medium to transmit multiple cues, feedback immediacy, language variety, and the personal focus of the medium [Dennis and Kinney, 1998]. Among the four factors, multiple cues and language variety can be designated as symbol variety [Daft and Lengel, 1986; Dennis and Valacich, 1999]. Mul-

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1) We have found only one empirical study on the media synchronicity has been conducted : Munzer and Holmer [2009] examined the effects of parallelism, immediacy of feedback, and reprocessability on task performance. Among five characteristics, symbol variety and rehearsability were not tested in Munzer and Holmer [2009]. Therefore, we focus on the effect of symbol variety in our lab experiment.

tiple cues refer to the number of ways in which information can be communicated such as text, verbal cues, or nonverbal cues [Dennis and Kinney, 1998]. Language is a system of spoken or written symbols that can communicate ideas, emotions, and experiences [Daft and Wiginton, 1979; Hollander, 1971]. If a language has a large pool of ideas, emotions, and experiences, then the language would have high symbol variety [Daft and Wiginton, 1979].

Based on these concepts of symbol and communication expression, Dennis and Valacich [1999] explained four methods for the symbol variety, a media characteristic, to affect the understanding of the message and communication process activity : 1) it would be easier to deliver information in a single format rather than many different formats; 2) verbal and non-verbal symbols allow the possibility to deliver more information than a sender can express; 3) when communicators establish a symbol set to create a message or process a delivered message, there would be a process cost or loss depreciating the level of the receiver's understanding; and 4) if there is no verbal or non-verbal symbol, the communicators could be significantly lacking in terms of social acknowledgement.

As mentioned above, symbol variety plays a significant role as a basic media characteristic to facilitate and promote communication. Symbols include various expressions of linguistics, signs, and non-verbal cues. Among these symbols, this paper focuses on the emotional sign and non-linguistic symbol expression-i.e., emoticon-typically appearing in the process of com-

puter-mediated communication. The term, emo-
ticon, a modern day pictograph, is the combina-
tion of the two words : emotion and icon. Icon
is a particular symbol used in the cyber world
delivering a subtle sense by using images of
typography, numbers, and letters on a computer
display screen. Emoticon has become a solution
to overcome the limitations of text-based com-
munications such as e-mail and internet chat-
ting [Raymond, 1994; Rheingold, 1993]. The fol-
lowing are features of emoticon :

- Emoticon makes simple and mechanical
  messages tender and soft.
- Emoticon helps to deliver messages in an
  emotional and subjective manner.
- Emoticon can complement and emphasize
  a certain message.
- Emoticon helps the receiver to understand
  a message by making text content more
  vivid and accurate.
- Emoticon establishes a communication en-
  vironment that is very similar to that of
  face-to-face communication.
- Emoticon can allow communicators to feel
  familiar with each other by complementing
  text-based expression as richer and fri-
  endlier.

These features of emoticon play key roles in
cyber communities that are organized and main-
tained by active interactions between parti-
cipants, because the use of various symbolic
icons along with text-based language can im-
prove interactions among the participants. By
using emoticons, furthermore, participants in
cyber communities can generate a unique at-
mosphere with their inherent styles in terms of

expression, symbol, and meaning.

2.2 Online Relationship

Online relationship is interpersonal and in-
timate relationship between people who have
met online. Rheingold [1993] argued that emo-
tion can be used in computer mediated com-
munication (CMC) environments to build online
relationships. CMC heavy users are able to
make friends and CMC moderate users are also
able to create solidarity between communica-
tion participants [Rheingold, 1993]. Rheingold
[1993] also explained the use of emoticon can
complement non-verbal cues in text-based CMC
environments. As emoticon is actively used
among members in virtual teams, an online
relationship among members could be even
transformed into an off-line relationship [Lea
and Spears, 1995; Parks and Floyd, 1996].
Romance and even marriage could be realized
in the online relationship [Buckman, 1992; Utz,
2000].

A virtual team using text-based media tends
to create a loose and weak relationship among
participants because the team has a difficulty to
deliver social and emotional meanings among
members [Burke and Chidambaram, 1999; War-
kentin et al., 1997]. Jarvenpaa and Leidner [1999]
found that even a virtual team can build a
higher level of mutual trust if only the team
made an effort to create an abundance of social
communication. Robey et al. [2000] also insisted
that more active communication could build a
better social and emotional relationship in CMC
contexts.

3. Research Model and Hypotheses

3.1 Research Model

The purpose of this study is to examine the impacts of symbol variety on group performance in virtual teams. <Figure 1> presents its research model.
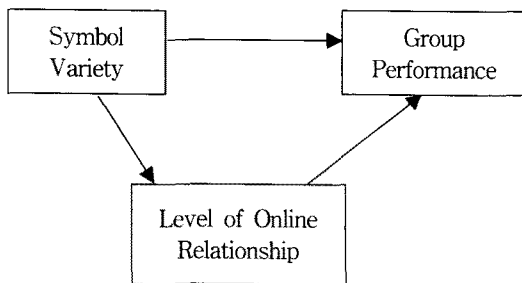
<Figure 1> Conceptual Model of Symbol Variety and Group Performance

As shown in <Figure 1>, symbol variety that is a cognitive characteristic of media is expected to affect the performance of group discussion. The text-based communication with emoticon is assumed to have more symbol variety than the text-based communication without emoticon use. Online relationship building is incorporated into the research model as a mediating variable between symbol variety and group performance. Group performance is expected to be directly and indirectly associated with the degree of symbol variety. The performance of virtual teams is measured by the team members' perceived level of satisfaction regarding the group discussion and the team members' perceive level of communication effectiveness. The measure for these variables is presented in 4. Method section.

3.2 Hypotheses

Based on literature review and research model, two main hypotheses are established. Virtual team members can apparently acquire a personal impression of other members when they receive social cues expressed in socio-emotional symbols [Tidwell and Walther 2000]. Therefore, high symbol variety communications among members can yield a better group discussion performance in virtual teams. Accordingly, hypothesis 1 is established as follow :

Hypothesis 1 : *The greater the use of high symbol variety communications among virtual team members, the greater the group performance in virtual teams.*

A strong online relationship among virtual team members can improve productivity in group discussion because the strong online relationship can resolve equivocality and reduce uncertainty in communications among them. When virtual team members experience a strong online relationship, they can achieve a more intensive and integrated output fit for assigned group tasks [Huang et al., 1998]. Hence, if virtual team members can feel more comfortable and friendly with other members by building a strong online relationship, then the group performance in the virtual team such as members' satisfaction and effectiveness of communications should be increased.

On the other hand, since the use of computer media having a high level of symbol variety in virtual teams can do more dynamic interaction

and get abundant information with other members, it helps the virtual teams to build a strong online relationship among their members. Hence, the online relationship among virtual team members has a mediator role between the level of symbol variety and group performance. Therefore, the following hypothesis is established :

Hypothesis 2 : *The extent to which virtual team members build online relationship among them mediates the impact of symbol variety on the group performance in virtual teams.*

4. Method

4.1 Laboratory Experiment

To test the two hypotheses, a controlled lab experiment was conducted. Two virtual team settings were organized. The virtual team settings were developed by separating virtual team members by wall-to ceiling partitions. In the virtual team settings, people could neither see nor hear each other. Their discussion was conducted solely via electronic textual cues. While members in the experimental virtual team were able to use emotional graphic cues additionally, the control group members were not allowed to use any emotional graphic cues. Ten teams were assigned to each of the two virtual teams. Each team was composed of 3 members with no group history, which means a total of sixty subjects were participated in the lab experiment. Subjects were undergraduate students from a university in Korea. The MSN messen-

ger program was employed as the communication technology in this lab experiment because it is well known as an Internet chatting program and most widely used in Korea.

An asset allocation task that is one of the preference fit tasks was utilized in this lab experiment. The task was assigned to each of teams and all subjects were requested to provide their own preferred answer. The asset allocation task was used in several previous GSS studies [McGrath and Hollingshead, 1994; Watson et al., 1998]. Based on the similar task used by Watson et al. [1998], the content of the task for this study was developed. The task requires subjects to allocate their fund into several research projects. The task used in the experiment is provided in the appendix. Prior to the main experiment, a pilot test was conducted to complement and revise the task content and the experiment procedure. Subjects were randomly assigned into each of the two virtual team settings. By using MSN messenger, subjects were allowed to directly communicate with other group members without the facilitators' assistance.[2]

4.2 Measure of Online Relationship Building and Group Performance

(1) Online Relationship Building

Forty three questions with Likert 7-point scale were used to measure the variable of online relationship building [Parks and Floyd, 1996]. The

2) The experimental procedure was not described for want of space. On request, the description of experimental procedure is available from authors.

measurement items had seven categories; 1) interdependence, 2) breadth of interaction, 3) depth of interaction, 4) code change, 5) interpersonal predictability and understanding, 6) commitment, and 7) convergence of the participants' social networks (see <Table 1>). Parks and Floyd [1996] developed the items from literature pertaining to the process of relationship development [Altman and Taylor, 1973; Huston and Burgess, 1979; Parks and Adelman, 1983] and employed these items to conduct a field survey on the communications of Internet news debaters, the news group, and Usenet. The seventh category, i.e., the convergence of the participants' social networks was dropped out for this study since the category was only useful for the development of an off-line relationship through an online relationship.

<Table 1> Measurement Items of Online Relationship Building

Category	Number of Items
Interdependence	7
Breadth of interaction	4
Depth of interaction	8
Code change	6
Interpersonal predictability and understanding	5
Commitment	5
Total	35

(2) Group Performance

Satisfaction and communication effectiveness were measured as the group performance. Five items were used to measure the satisfaction with the process of group discussion and another five items were employed for the satisfaction with the result of the group discussion. Ten questions with the Likert 7-point scale were used to measure how effective the group discussion was, based on items of communication effectiveness created by Burke and Chidambaram [1992].

5. Results

The descriptive statistics are provided in <Table 2>. As shown in <Table 2>, online relationship building and group performance have different mean value in the two virtual team settings.

To examine the statistical significance of the impacts of the differences, the PLS method was used. Using PLS, the reliability and validity of the measurement items were first tested and then the path analysis for hypothesis testing was conducted.

5.1 Test of Measurement Model

The measurement model was tested by exa-

<Table 2> Means and Standard Deviations of Variables

Symbol Variety	Online Relationship Building (SD)	Communication Effectiveness (SD)	Satisfaction (SD)
Text-based Communication with Emoticon	4.50 (1.75)	5.32 (1.52)	5.52 (1.07)
Text-based Communication without Emoticon	4.09 (1.76)	4.90 (1.57)	4.99 (1.25)

〈Table 3〉 Loading and Cross-Loading of Measurement Items

Items	Online Relationship Building	Communication Effectiveness	Satisfaction
Interdependence	0.75	0.47	0.55
Breadth of interaction	0.63	0.42	0.47
Depth of interaction	0.69	0.39	0.46
Code change	0.70	0.30	0.34
Interpersonal predictability and understanding	0.58	0.31	0.37
Commitment	0.74	0.42	0.55
Communication effectiveness 1	0.25	0.47	0.25
Communication effectiveness 2	0.34	0.60	0.34
Communication effectiveness 3	0.18	0.43	0.40
Communication effectiveness 4	0.18	0.36	0.38
Communication effectiveness 5	0.56	0.85	0.68
Communication effectiveness 6	0.47	0.84	0.61
Communication effectiveness 7	0.37	0.68	0.53
Communication effectiveness 8	0.38	0.71	0.60
Satisfaction 1	0.48	0.66	0.79
Satisfaction 2	0.32	0.46	0.58
Satisfaction 3	0.42	0.23	0.45
Satisfaction 4	0.45	0.57	0.78
Satisfaction 5	0.47	0.51	0.68
Satisfaction 6	0.40	0.61	0.59
Satisfaction 7	0.57	0.51	0.73
Satisfaction 8	0.35	0.41	0.64
Satisfaction 9	0.43	0.40	0.62
Satisfaction 10	0.61	0.72	0.87

Note : Numbers in shaded cell are greater than 0.6, which are adopted as measurement items for the path analysis.

mining reliability, internal consistency, and discriminant validity for the measurement items. Individual item reliability was assessed by examining the factor loading of each item on its respective construct. A general guideline is to accept items with a loading of 0.7 or greater [Chin, 1998]. However, it was important to retain as many items as possible from the original scale to preserve the integrity of the original research design and to compare the results with other studies that use the same scales [Barclay et al., 1995; Duxbury and Higgins, 1991; Yoo

and Alavi, 2001]. Therefore, the lower cut-off point of 0.6 factor loading was applied and 3 items were dropped from the satisfaction and communication effectiveness, respectively. For online relationship building, the interpersonal predictability and understanding was dropped because it had a lower factor loading than 0.6[3]. 〈Table 3〉 shows the factor loadings and cross-

3) The online relationship building was measured as a second order factor, which was assessed by items from subordinate variables. The reliability and validity of the first order factors were tested.

factor loadings of measurement items. Except for the dropped items, all items met the criterion of a factor-loading greater than 0.6.

Internal consistency was examined using the composite scale reliability index (CSRI) developed by Fornell and Larcker [1981], which is a measure similar to Cronbach's alpha. Fornell and Larcker [1981] recommend using a criterion cut-off of 0.7 or higher. As shown in <Table 4>, all constructs met the recommended criterion.

To assess the discriminant validity, Fornell and Larcker [1981] suggest the use of average variance extracted (AVE), which is the average variance shared between a construct and its measures. They recommend that the square root of the AVE for each construct should be greater than the correlations with other constructs. In <Table 4>, the diagonal elements represent the square root of the AVE and the off-diagonal elements show the correlations with other constructs. <Table 4> shows that all constructs met the requirement.

5.2 Test of Structural Models and Hypotheses

<Table 5> shows the results of the structural model assessment. As shown in <Table 5>, symbol variety significantly influenced the online relationship building (path coefficient = 0.37, p = 0.001) and then the online relationship building affected communication effectiveness (path coefficient = 0.58, p = 0.000) and satisfaction (path coefficient = 0.62, p = 0.000). However, the direct impact of symbol variety on

<Table 4> AVE and CSRI

	Number of Items	CSRI	Online Relationship Building	Communication Effectiveness	Satisfaction
Online Relationship Building*	5	0.84	0.71		
Communication Effectiveness	5	0.87	0.57	0.75	
Satisfaction	7	0.90	0.65	0.72	0.75

Note) * This construct is a second-order factor.

<Table 5> A Summary of the Structural Model

Path		Path Coefficient	t-value	p-value
From	To			
Symbol Variety	Online Relationship Building	0.37	3.15	0.001**
R^2 = 0.14				
Symbol Variety	Communication Effectiveness	-0.018	0.14	0.445
Online Relationship Building	Communication Effectiveness	0.58	6.52	0.000**
R^2 = 0.33				
Symbol Variety	Satisfaction	0.086	0.75	0.228
Online Relationship Building	Satisfaction	0.62	7.17	0.000**
R^2 = 0.43				

Note) * $p < 0.05$; ** $p < 0.01$.

communication effectiveness and satisfaction was found insignificant.

Based on the results of the path analysis, hypothesis 1 (a high level of symbol variety causes a high level of group performance) was not supported. However, hypothesis 2 (the level of online relationship building mediates the relationship between symbol variety and group performance) was supported.

6. Conclusion

6.1 Summary of Results and Discussion

The purpose of this study was to investigate the direct and indirect impacts of symbol variety on group performance in virtual teams. By conducting a controlled lab experiment using sixty undergraduate students, this study shows that symbol variety did not directly affect group performance but indirectly affected the group performance by building an online relationship among virtual team members.

The main results of this study imply that communication media with a high level of symbol variety help virtual team members to improve information sharing through an online relationship development. When a virtual team achieves a stronger online relationship and team members have a familiar impression about other members, the virtual team can achieve a high productivity in terms of the group discussion.

The results support the traditional media richness theory and social presence theory. This study proves that CMC having a rich media helps team members to easily understand what

situation they are in, can produce a consensus among team members more quickly, and can solve several equivocal tasks [DeStepen and Hirokawa, 1998; Gouran and Geonetta, 1997; Kline and Hollinger, 1976; McGrath and Hollingshead, 1994].

This study also finds that the use of CMC with high symbol variety is associated with a higher level of online relationship building than the use of CMC with low symbol variety. This result is consistent with previous studies arguing that group members have a more apparent impression and build a better relationship when they can acquire social cues via an emotional expression [Tidwell and Walther, 2000]. The higher level of online relationship was found to cause a higher level of group performance in virtual teams. This indicates that the virtual team members who have a friendly relationship with other members are more satisfied with their discussion performance. The result suggests that the strong online relationship allows virtual team members to exchange social influence and be in a friendlier mood, which result in formalizing an adequate social norm as to achieve a more productive and task-oriented performance even in the new condition of CMC [Huang et al., 1998].

6.2 Implications and Limitations

This study provides implications for managers and researchers. For managers, this study implies that firms should use media with high symbol variety in group discussion tasks to accomplish a good performance, favorable con-

sensus, and active information exchange. Second, because firms have increasingly adopted digitalized communications for public relations and investor relations, this study implies that the use of high symbol variety media could give a favorable image to external stakeholders. Third, this study would be helpful for digital content businesses relying on online communication. For example, online game developers could create more effective online chatting programs for multiple-user-dialogue games by improving the cognitive and emotional method of online communication. In brief, managers should consider symbol variety to improve virtual team performance.

Additionally, academic implications can be provided by this study. First, this study introduced a complemented research model that combines cognitive aspects and social relations of group decision-making contexts. A majority of the previous studies attempted to view the media effects in terms of one dimension, cognitive or social aspects. However, this study focused on a synthesized approach including both cognitive and social aspects. The research model used in this study incorporated symbol variety as a cognitive aspect as well as introduced online relationship building as a social aspect. Second, the results of this study could stimulate future research to focus on solving the constraints of CMC, which has been ignored by many previous studies. This study shows how to increase a symbol variety that affects group performance.

There are limitations to be considered for future research. First, this research has a limi-

tation in terms of external validity because a controlled lab experiment method was utilized. Future research should conduct research using other data sets from actual business environments and use other methods such as field surveys. Second, the participants of this experiment used the MSN chatting program. Future research needs to use other communication tools with different level of symbol variety. Finally, the online relationship among team members could not be built through a one-shot group discussion. Future research needs to conduct experiments in a series of group discussions.

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\<Appendix 1\> Lab Experiment Task

Discussion Topic

Your team is requested by the minister of education department to allocate one million dollars for research projects on the college entrance examination system. You should allocate the one million dollars through active communications with other members in your team into the six projects listed below. Your team has to determine how much each project is allocated. An individual project may require the entire one million dollars. Consider that your team allocates more money into projects that have a higher probability of success.

Each Research Project   Allocated Money

1. Research on the permission of high school classification   -------

2. Research on the prohibition of high school classification   -------

3. Research on the high school classification without any requirement   -------

4. Research on the three issues without any requirement : high school classification,
   final entrance examination hosted by university, and donation entrance   -------

5. Research on the restructure of the policy-making ability of the education department
   of the government   ------

6. Fundamental research on human resource development of Korea   -------

   Total Budget Amount   *$ 1,000,000*
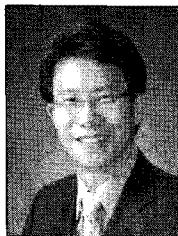
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