CHANNEL AND RECIPIENT CHARACTERISTICS: EFFECTS ON

COMMUNICATION EFFECTIVENESS AND PERFORMANCE

By

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To the faculty of Washington State University:

  The members of the committee appointed to examine the dissertation of CHRISTOPHER SCOTT find it satisfactory and recommend that it be accepted.

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Chair

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I dedicate this dissertation to my loving wife, Anne, who has been a constant and unyielding support for me as I have embarked on this dissertation and my academic career. I am forever grateful for her sacrifice. I also dedicate this work to my children, Mary and Jacob, who are steady and reliable sources of joy and wonder, and provide continual motivation for me to improve and excel as a scholar. I would also like to thank my parents, Kent and Didi, for their unwavering confidence in me. Without their support, sometimes under duress, as I was growing up I wouldn't have achieved all that I have.

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ABSTRACT

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One significant problem that organizations face today is their ability to disseminate information within and across their organizational boundaries efficiently. The purpose of this dissertation is to examine how communication media with different characteristics, and individual recipients with different characteristics, influence the performance of the message recipients on tasks that are dependent on the message. Well known communication media theories (e.g., Daft & Lengel, 1986) have come under scrutiny for weak empirical support and newer theories have emerged (e.g., Dennis, Fuller, & Valacich, in press) that will require empirical testing to validate. This dissertation represents an initial empirical test of several elements of *Media Synchronicity Theory* (MST). This dissertation is composed of three essays which describe a series of empirical studies. The studies were carried out (1) to create measurement scales to psychometrically assess individuals' perceptions of media characteristics/capabilities; (2) to experimentally manipulate two media capabilities and evaluate downstream, individual performance relative to a communicated message; and (3) to assess recipient retention of

communicated information after a time delay from the experimental manipulations of media capabilities.

The ultimate goal of this research is to provide a rigorous, tightly controlled evaluation of several aspects of MST, and to propose and test two media appropriation factors as an extension to MST. This dissertation is organized in the following manner. The first chapter provides an introduction to the three essays. This introductory chapter will provide a brief theoretical discussion of MST, how MST has evolved over the last decade, and brief introductions to each essay. The second chapter includes the first essay, which will describe the instrument development studies. The third chapter includes the second essay, which will describe the first experimental study. The fourth chapter, containing the third essay, will describe the follow-up experimental study that incorporates a longitudinal aspect into the research model. Finally, the fifth chapter is composed of a summary section that will briefly discuss the dissertation as a whole.

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CHAPER ONE

Introduction

Problem and Research Questions

With the increasing variety of communication media in organizations today—traditional forms such as telephone, written memo, face to face, and "new media" such as email, instant messaging, text messaging, and video conferencing—understanding the factors that influence communication effectiveness is still needed, particularly with a strong theoretical basis. One weakness of previous research regarding communication media results from researchers who have focused on empirically testing managers' choice of media, rather than testing performance relative to the message (Dennis & Kinney, 1998; Dennis, Fuller, & Valacich, in press).

Media richness theory was originally developed to indicate which media would be ideal given certain organizational conditions (Daft & Lengel 1986), however, empirical tests of media richness theory have been equivocal (e.g., Burke & Chidambaram 1999; Dennis & Kinney 1998; Ngwenyama & Lee 1997) due in part to the focus on choice rather than performance. Alternatively, media synchronicity theory argues that human communication requires both conveyance of information (transmission), and convergence on a shared meaning (information processing), and provides a taxonomy of media characteristics that can impact a medium's ability to support conveyance and convergence (Dennis et al., in press). To begin a systematic research program to empirically test media synchronicity theory, this dissertation will examine the following four research questions:

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RQ1:   *Do individuals perceive a medium's characteristics consistent with media synchronicity's media capabilities?*

RQ2:   *How do various channel characteristics influence communication effectiveness from the recipient's perspective?*

RQ3:   *What recipient characteristics are important for effective communication?*

RQ4:   *How do channel and recipient characteristics influence memory and recall over time?*

Importance of Research

In resolving the research questions above, this dissertation aims to provide more detail with regard to media characteristics and their effects on communication and downstream performance than has been obtained in prior research. Complementary theories to Daft and Lengel's Media Richness Theory (1986) have emerged (Carlson & Zmud 1999; Dennis et al., in press) that can provide a finer level of detail regarding the characteristics of a communication channel. Understanding the theoretical mechanisms that impact communication effectiveness at such a finer level of detail will be necessary as organizations seek to optimize communication effectiveness by configuring their internal and external communication channels.

Furthermore, media theories developed as a response to media richness theory have also identified the communicators themselves as important elements, besides the media characteristics alone, that would impact the effectiveness of a communication event. From a performance-based view of media (rather than choice-based), particularly in organizational situations where a message is transmitted to affect some performance on

the part of the recipient, this research will focus on the recipient as the recipient is responsible for ultimately acting on the message that is sent. Therefore, this research intends to examine individual level recipient characteristics as directly effecting their ability to receive a message and act on it, along with interactive effects between channel and recipient characteristics, on communication effectiveness. In understanding individual differences between organizational members regarding their abilities to receive a message, and how those abilities interact with channel characteristics, this research aims to provide managers with actionable advice on configuring channels and messages depending on recipient characteristics to enhance the recipient's ability to perform regarding the message.

History of Media Synchronicity

Media synchronicity theory (MST) (Dennis & Valacich) was originally published as a conference proceeding at the Hawaii International Conference on System Sciences (HICSS) in 1999. The HICSS version of MST was confined to a 10 page conference paper. The HICSS version discussed the weaknesses of previous media research to identify an area that still needed theorizing.

To address the weaknesses of previous research, Dennis and Valacich argued that previous media research had focused on "task" at too high a level. That is, when considering the nature of media with respect to communication, researchers should examine the underlying communication-specific task that the communicators are engaged in. Dennis and Valacich referred to two underlying communication processes and referred to them as conveyance and convergence. Furthermore, they argued that

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conveyance tasks would benefit from media capabilities that do not support synchronicity (i.e., "the extent to which individuals work together on the same activity at the same time" (Dennis & Valacich, 1999, p. 5)), and that convergence tasks would benefit from media that so support synchronicity. As with other media theories, the HICSS version of MST also identified several media capabilities, and argued for their relative importance depending on whether conveyance or convergence is the communication process in question. Finally, the authors began to acknowledge the social aspect of communication processes and theorized that as the communicators, or members of a group, work together over time, their reliance on synchronicity and therefore media capabilities that support synchronicity is less than newly formed groups or groups without accepted norms.

Despite its brief nature, the HICSS version of MST began to be examined by other researchers, even with its publication as a conference proceeding. Several dissertations (Huber, 1998; Rodgers, 1999; Sidorova, 2002; Hamrick, 2004; Zou, 2007) and journal articles (Carlson & George, 2004; Maruping & Agarwal, 2004; Hill & Roldan, 2005; DeLuca & Valacich, 2006) have used the HICSS version of MST as an element of their research. In some cases, these researchers experienced resistance from reviewers regarding the use of a conference paper for a significant theoretical element of these papers.

In the decade following the publication of MST at HICSS, Dennis and Valacich added a co-author, and more fully developed the theory so that it could be published in an archival journal. The forthcoming version of MST (Dennis, Fuller, & Valacich, in press) is not only more fully developed than the HICSS version, but also more fully articulates the full socio-technical aspects of communicating with various media.

Considering the forthcoming version of MST and its stronger theoretical basis, this dissertation seeks to begin systematic empirical testing of MST. Previous research using the HICSS version of MST have examined various elements of MST in the context of other issues, such as deception (Carlson & George, 2004), virtual teams (DeLuca & Valacich, 2006; Maruping & Agarwal, 2004), and cross-cultural issues (Sidorova, 2002). This dissertation examines several tenets of MST in the context in which the theory is situated, communication effectiveness.

Organization and Format

This dissertation is organized in the following manner. The first chapter provides an introduction to the three essays. This introductory chapter discusses the nature of the problem and why this research is important. The second chapter includes the first essay, which will describe the instrument development studies. The third chapter includes the second essay, which will describe the first experimental study. The fourth chapter, containing the third essay, will describe the follow-up experimental study that incorporates a longitudinal aspect into the research model. Finally, the fifth chapter is composed of a summary section that will briefly discuss the dissertation as a whole.

CHAPTER TWO

ESSAY 1

Development of an Instrument to Measure

Individual Perceptions of Five Media Characteristics

Introduction

The purpose of this paper is to develop a measurement instrument to assess five

media characteristics proposed by Dennis, Fuller, and Valacich (in press). Dennis and

colleagues' Media Synchronicity Theory builds upon Daft and Lengel's (1986) Media

Richness Theory to describe the role of the communication channel in the development

of a shared understanding between two (or more) communicators. They propose that the

completion of tasks relies on two "fundamental communication processes" (Dennis et al.,

in press, p. 12). That is, conveyance of information, and convergence on a shared

meaning are required for successful communication within a group environment.

Furthermore, they argue that more efficient communication will occur when the level of

"media synchronicity," or "the extent to which the capabilities of a communication

medium enable individuals to achieve synchronicity – to work together at the same time

with a shared pattern of coordinated behavior," (Dennis et al., in press, p. 10) more

closely matches the needs of the communication task. Their theory enumerates five

media characteristics that impact the communication channel's ability to support

conveyance and convergence processes, which subsequently determine the level of

synchronicity between the communicators. This paper explores the five characteristics

proposed by Dennis, Fuller, and Valacich, which are transmission velocity, parallelism,

symbol sets, reprocessability, and rehearsability (in press). Each of these will be defined

and discussed below.

<div align="center">Constructs and Item Generation</div>

Transmission Velocity

Transmission velocity is defined as "the speed at which a medium can deliver a

message to intended participants" (Dennis et al., in press, p. 20). A medium with high

transmission velocity, such as face-to-face communication, allows the communicators to

more quickly come to a shared understanding by allowing "mid-course" corrections so

that misunderstandings can be minimized.

Symbol Sets

Symbol sets refers to the "number of ways in which a medium allows information

to be encoded for communication" (Dennis et al., in press, p. 22). That is, in a face-to-

face conversation, in addition to the verbal content, vocal inflection, body language and

gestures also convey meaning. Whereas, a telephone conversation may only be able to

support the verbal and (limited) vocal inflection elements of the conversation. Several

types of electronic media can now support live video and audio while supporting text and

image presentation to support the speaker, which would be considered as media having

multiple symbol sets (Dennis et al., in press).

Parallelism

Parallelism refers to the medium's ability to support multiple, simultaneous conversations. An established telephone circuit, for example, can effectively only support one conversation at a time, while some electronic media can be configured to support many simultaneous conversations (e.g., instant messaging) (Dennis et al., in press).

Rehearsability

Rehearsability refers to the medium's ability to allow the sender to edit and fine tune the message to ensure that the intended meaning is captured. While a face-to-face conversation allows for little if any rehearsability, an e-mail message could be edited as often as necessary prior to clicking the "send" button (Dennis et al., in press).

Reprocessability

Reprocessability refers to the medium's ability to allow the recipient to re-examine the sent message within the context of the communication event. So, during a face-to-face conversation, there is no external memory that stores the content of the message so that the communicators can process the message multiple times. Similarly, without recording equipment, a telephone conversation is not maintained so that the participants can review the content. However, an e-mail message can be stored, even if only short-term in RAM while it is displayed on the screen, so that the communicator can continually refer back to it during the email exchange (Dennis et al., in press).

Item Generation

To ensure content validity, items for each construct were developed by examining each of the construct definitions and consulting with several junior researchers who were familiar with Media Synchronicity Theory. Twenty items, including reverse scored items, were developed for each construct for a total of 100 items (see Appendix A for the items and instructions for the first round of data collection). The items were developed to assess an individual's pre-conceived perceptions of a medium's characteristics. Hence, each item was developed so that any medium can be assessed. For example, the first item for immediacy of feedback is worded as: "[The medium] allows me to provide immediate feedback to the person I'm communicating with," where [The medium] is a placeholder for whichever medium is being assessed. Additional research will develop items to assess context and interaction-dependent perceptions of a medium immediately following the medium's use.

Method – Data Collection 1

Sample

The sample for the first data collection was composed of 37 participants. The participants were recruited from an on-line message board and from undergraduate students enrolled in an on-line Database management course at Washington State University. Fourteen males from the online message board and 16 male and 7 female participants from the Database management course took part in this first data collection.

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Survey Administration

The survey was administered by providing a link to the on-line survey on the on-line message board and in the course's Web-CT course space for the students to complete for extra credit. After clicking the link, the participants were presented with a short description of the survey and given the option to decline to participate. After completing the survey, the participants were presented with a short debriefing statement describing the goals of the study. The survey items were specified for the recipients to respond based on their perceptions of e-mail by replacing the [medium] placeholder with the term e-mail.

Results and Refinement – Data Collection 1

The purpose of the first data collection was to assess the basic measurement properties of the 100 generated items (e.g., internal consistency and exploratory factor analysis (EFA)), and thus, to refine the instrument to roughly 5 items per construct. With this goal in mind, the first step in the analytic strategy was to assess the internal consistency using SPSS 11.0. Additionally, skewness and kurtosis were assessed to determine the extent of normality of the scales' distributions with future SEM analyses in mind. Table 2.1 presents each construct and its scale's associated Cronbach's alpha, skewness, and kurtosis values.

Table 2.1: Summary of reliability, skewness and kurtosis results.

Skewness and kurtosis values represent the items with the lowest and highest skewness and kurtosis values, respectively for each scale.

Scale	α	skewness		kurtosis	
		Low	High	Low	High
Transmission Velocity	.9539	-1.109	.054	-1.152	.906
Symbol Sets	.9856	-.996	-.087	-1.335	.067
Parallelism	.9889	-1.064	-.469	-1.103	.323
Rehearsability	.9804	-2.833	-1.937	3.468	9.570
Reprocessability	.9834	-2.302	-1.166	.468	6.334

According to Nunnally and Bernstein (1994), in applied contexts "where important decisions are made with respect to specific test scores, a reliability of .90 is the minimum that should be tolerated, and a reliability of .95 should be considered the desirable standard" (p. 265). Given Nunnally and Bernstein's standard and the initial stage of this research, care must be taken when assessing the reliability of the media synchronicity scales. While they all exceed Nunnally and Bernstein's suggested desirability level, this is more than likely due to the items being overly similar, and having 20 items per scale.

The next step in the analytic strategy for the first data collection was to perform an Exploratory Factor Analysis (EFA) to determine the factor structure of the items on any latent factors. A Principle Components Analysis was performed with Varimax rotation using SPSS 11.0 to generate a scree plot. The EFA converged after 9 iterations

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on 12 components, however, after examining the scree plot and the eigenvalues of the items there were 7 components with eigenvalues greater than 2.0. Further examination of the rotated component matrix (see Appendix B) indicated that that there were 5 components with items with loadings higher than 0.7 and no cross-loaded items. Given the values of the item loadings, the final instrument was refined by retaining the five items for each construct with the highest factor loadings for that construct. See Appendix C for the final instrument.

Method – Data Collection 2

Sample

The sample for the second data collection was composed of 288 Washington State University undergraduate students enrolled in an introductory Management Information Systems course. 33.4% of the participants were female and 66.6% of the participants were male.

Survey Administration

The survey was administered to the participants as part of their regular class meeting time for course credit amounting to roughly one percent of their total grade for the course. Upon arriving at their regularly schedule class time, the participants were given a brief description of the purpose of the survey, their informed consent was obtained, then they were given the URL for on-line delivery of the survey. After completing the survey, the participants were debriefed. As with the first data collection, the items were worded to assess the participants' perceptions of email.

Results – Data Collection 2

The purpose of the second data collection was to collect a second sample on the refined instrument to replicate the factor structure of the original EFA and to assess convergent and discriminant validity. To achieve these goals, the analysis was carried out in two stages. To assess the factor structure of the second sample, the first stage consisted of a CFA conducted using EQS 6.1 to obtain model fit statistics. The second stage of analysis was carried out using PLS Graph 3.00 Build 1126[1] and followed Gefen and Straub's (2005) procedure for demonstrating convergent and discriminant validity.

Model Fit

Considering the skewness and kurtosis values reported for the first data collection, the CFA was performed using the EQS Robust estimation technique (Curran, West, & Finch, 1996). See Table 2.2 for fit indices. With a X^2/df of 1.78, and CFI and SRMR meeting acceptable thresholds for fit (Gefen, Straub, & Boudreau, 2000; Kenny, 2003) and RMSEA close to the .050 threshold for acceptable fit, the data appear to fit the model well.

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[1] Ideally, one would prefer to use one software package to perform all stages of these analyses. However, the PLS Graph software (used to follow Gefen and Straub's factorial validity procedure) does not provide model fit statistics. According to Chin (1998) these indices are not included in an effort to avoid confusion when both formative and reflective constructs are used and he argues that "closer attention to the predictiveness of the model" (p. XV) should be paid. Given that CFA is the only analysis being carried out (no structural model), EQS was used to assess model fit, while PLS Graph was used to demonstrate factorial validity

Table 2.2: CFA fit statistics (ROBUST)

df	S-B chi-square	CFI	SRMR (non-Robust)	RMSEA	90% CI for RMSEA
265	470.4	.971	.060	.052	.044 - .059

Factorial Validity

To establish convergent and discriminant validity of the media characteristic

constructs, a CFA using PLS Graph was carried out. Gefen and Straub (2005) suggest

that to establish convergent validity, the measurement items for each construct loads with

a significant t-value – greater than 1.96 – on its respective latent construct. Table 2.3

presents the item loadings and t-values for each item on its latent construct. With the

exception of the two reverse scored items—the third item for parallelism and the fifth

item for rehearsability—all items loaded on their construct with loadings above the .707

threshold and have t-values above the 1.96 cutoff (Gefen & Straub, 2005), thereby

suggesting that the items demonstrate convergent validity.

Two procedures are suggested to establish discriminant validity. First,

examination of the correlations between the items and their latent variable scores

establishes that "the measurement items load highly on their theoretically assigned factor

and not highly on other factors" (Gefen & Straub, 2005, p. 93). While no established

benchmarks exists to evaluate these correlations by, Gefen and Straub conservatively

suggest that the correlation between an item and its respective construct should exceed

.70, and that the correlations between items and the other constructs should be below .60

(2005).

Table 2.3: Item loadings and t-values

Construct	Item	Outer Model Loading	t-value
Transmission Velocity	ETV1	.8692	17.2228
	ETV 2	.8665	17.0883
	ETV 3	.9057	44.4097
	ETV 4	.8625	26.1959
	ETV 5	.9024	41.4943
Parallelism	EP1	.9555	132.2399
	EP2	.9493	73.0292
	EP3reverse scored	.4097	4.4900
	EP4	.9365	70.6524
	EP5	.9469	105.5912
Rehearsability	ERH1	.9157	32.2343
	ERH2	.9653	112.8434
	ERH3	.9572	92.8085
	ERH4	.9335	47.7885
	ERH5reverse scored	.1833	2.0115
Reprocessability	ERP1	.9648	139.6353
	ERP2	.9435	51.4339
	ERP3	.9481	68.1390
	ERP4	.9644	103.1934
	ERP5	.9510	61.6295
Symbol Sets	ESV1	.9455	75.0158
	ESV2	.9689	151.7592
	ESV3	.9697	153.4599
	ESV4	.9747	185.8150
	ESV5	.9745	190.9084

Considering the concerns of normality noted above, nonparametric Spearman correlations were conducted (Siegel & Castellan, 1988) and are presented in Table 2.4. Consistent with the convergent validity tests above, all items loadings correlate highly with their respective construct except for the two reverse scored items, EP3REV and ERH5REV. Furthermore, all items have low correlations with the other constructs indicating discriminant validity.

Table 2.4: Item loading-Construct correlations

		Construct				
		ETV	EP	ERH	ERP	ESV
	ETV1	**0.876**	0.146	-0.051	0.071	0.251
	ETV 2	**0.870**	0.133	-0.067	0.050	0.253
	ETV 3	**0.907**	0.244	-0.070	0.173	0.312
	ETV 4	**0.847**	0.214	0.016	0.254	0.349
	ETV 5	**0.923**	0.208	-0.101	0.131	0.274
	EP1	0.234	**0.952**	0.180	0.442	0.203
	EP2	0.235	**0.950**	0.139	0.446	0.187
	EP3REV	0.048	**0.415**	0.094	0.242	0.027
	EP4	0.214	**0.933**	0.116	0.438	0.200
Measurement Items	EP5	0.208	**0.949**	0.140	0.453	0.200
	ERH1	-0.069	0.178	**0.914**	0.376	0.098
	ERH2	-0.046	0.175	**0.915**	0.379	0.145
	ERH3	-0.023	0.172	**0.926**	0.343	0.165
	ERH4	-0.045	0.189	**0.921**	0.352	0.161
	ERH5REV	-0.090	0.001	**0.466**	0.142	0.022
	ERP1	0.147	0.451	0.366	**0.966**	0.262
	ERP2	0.154	0.424	0.349	**0.947**	0.298
	ERP3	0.165	0.465	0.318	**0.941**	0.254
	ERP4	0.179	0.445	0.331	**0.969**	0.313
	ERP5	0.137	0.463	0.349	**0.951**	0.243
	ESV1	0.306	0.197	0.125	0.253	**0.941**
	ESV2	0.283	0.206	0.114	0.269	**0.960**
	ESV3	0.304	0.174	0.095	0.245	**0.961**
	ESV4	0.303	0.186	0.124	0.294	**0.960**
	ESV5	0.297	0.198	0.109	0.295	**0.963**

Note: Bolded correlations are the correlations between the measurement item and its theoretically assigned construct.

The second procedure for establishing discriminant validity is to examine each construct's squared Average Variance Extracted (AVE) relative to the correlations among the variables. That is, another aspect of establishing discriminant validity is to verify that the AVE of each construct is larger than all other correlations among pairs of constructs (Gefen & Straub, 2005). Table 2.5 presents each construct's squared AVE (bolded on the diagonal) along with the correlations among the pairs of constructs (off diagonal), along with each construct's composite reliability.

Table 2.5: Composite Reliabilities and square root of AVEs of the Constructs

	Construct	Composite Reliability	1	2	3	4	5
1	ETV – Trans.Velocity	0.948	**0.885**				
2	EP – Parallelism	0.934	0.241	**0.867**			
3	ERH – Rehearsability	0.917	-0.031	0.193	**0.847**		
4	ERP – Reprocessability	0.981	0.193	0.497	0.278	**0.954**	
5	ESV - Symbol Sets	0.986	0.379	0.217	0.167	0.281	**0.967**

Note: Square roots of AVE are presented in bold on the diagonal, with off diagonals highlighting the correlations between the constructs.

As with evaluating the item loading-construct correlations, there are no established thresholds for evaluating the AVE square roots relative to construct correlations (Gefen & Straub, 2005). However, as Gefen and Straub suggest, the square roots of the AVEs are quite higher than any other correlation among the constructs. Coupled with the item loading-construct correlation analysis above, these analyses provide initial evidence for the discriminant validity of the media characteristic scales. Additionally, the composite reliabilities for each of the constructs all exceed 0.9 and suggest that each scale exhibits appropriate internal consistency.

Discussion and Conclusion

This paper proposes and then tests the measurement properties of an instrument for assessing individuals' general perceptions of media characteristics. Items were generated, then refined with the first data collection to the current 25 item instrument.

The resultant 25 item instrument was administered to a large sample and underwent CFA, convergent, and discriminant validity analyses. The results from these analyses suggest that the entire instrument exhibits acceptable measurement properties, with the exception of two items—one tapping parallelism and one tapping rehearsability. These two items happen to both be the only reverse scored items in the refined instrument, which indicate the possibility that participants answered the survey items with a response set. Coupled with the relatively high composite reliabilities, the possibility of response bias due to response sets becomes a valid concern regarding the instrument.

Future Directions

This paper represents an initial attempt to develop and refine a media characteristics measurement scale. Initially, the results above are encouraging, however, further research is warranted to further replicate the factor structure and measurement properties of the scale. Future research should compare and contrast the individual scales to similar existing scales such as Daft, Lengel, and Trevino's (1987) multiplicity of cues, or Rice's (1987) editability, perhaps utilizing a multi-trait multi-method approach (Campbell & Fiske, 1959). Additionally, concerns noted above regarding the two reverse scored items that were retained for the refined instrument will need to be addressed in future research.

Future research will also need to be carried out to develop scales that can measure context-specific, or interaction-specific perceptions of media characteristics. That is, as Carlson and Zmud (1999) point out, as people become more familiar with the medium and/or with their communication partner, the perception of the medium's characteristics

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may change. Furthermore, email in general may be perceived as a medium with high parallelism, reprocessability, symbol variety, and rehearsability, but medium on transmission velocity, but situations may exist where, say an organization, has implemented a training program to encourage fast feedback when communicating by email. In such a case, members of that organization may in fact rate email as a high immediacy of feedback medium.

CHAPTER THREE

ESSAY 2

Examining the Role of the Communication Channel Interface and

Recipient Characteristics on Knowledge Internalization: A Pragmatist View

Introduction

With rapid developments of, and innovations in, different types of information

and communication technologies, and the increasing reliance of organizational members

on such technologies, research examining the users' interaction with IT has grown

exponentially in recent years (Zhang & Li, 2005; Siau, 2005). However, in a recent

review of this literature, Zhang and Li (2005, p. 254) have concluded that the focus of

current research has been predominantly on understanding the impact of IT use on

"cognitive beliefs and behavior," "performance/production," and "attitude and

satisfaction with IT," with very limited research investigating other critical issues such as

the effect of the IT on knowledge transfer and individual "learning."

It is useful to note that knowledge transfer has become a key topic in management

scholarship as well, with the increasing importance of strategic alliances, mergers and

acquisitions, and the realization among organizational members that effective

management and competitiveness relies on the ability to *share* knowledge among the

parties concerned, and to *learn* from each other (Mason, 2003; Argote, Ingram, Levine, &

Moreland, 2000). Despite such interest in knowledge transfer and recipient learning

across many disciplines (Schultz & Leidner, 2002), researchers argue that "this

multidisciplinary line of inquiry has generated a limited amount of empirical work"

(Simonin, 2004, p. 407). In this study, we therefore undertake an empirical examination of the recipient learning phase of knowledge transfer. In investigating this issue, we draw on the tenets of the "pragmatism" philosophy, which has recently begun to be used as a lens for examining issues related to knowledge management (e.g., Cook & Brown, 2002; Blosch, 2001)

In today's digital world, much of the knowledge transfer, and subsequent recipient learning happens through the computer-mediated environment and the use of knowledge-management systems (Alavi, 1994; Mason, 2003). On one hand, the use of computer-based systems adds to the efficiency and effectiveness of knowledge sharing and learning; on the other hand, due to a wide variety of factors such as features of the information systems being used (Taylor 2004) and the individual learner's (or the knowledge recipient's) characteristics, this sharing of knowledge and the subsequent learning can become "laborious, time consuming, and difficult" (Szulanski, 2000, p. 10). Specifically, past research has acknowledged that the richness of the communication channel (Daft & Lengel, 1986) through which the knowledge is shared, is a key determinant of the extent of learning by the recipient (Gupta & Govindarajan, 2000; Ghoshal, Korine, & Szulanski, 1994). On similar lines, scholars drawing upon the pragmatist philosophy (e.g., Smith, 1999) also argue that technologies have "certain generative essences (capacities)," which often affect the extent of knowledge being internalized by individuals (Blosch 2001, p. 43). However, in spite of this line of thinking being embedded in the discourse on knowledge management, there have been few (if any) systematic investigations into the effect of the characteristics of the communication

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channel on knowledge transfer and learning. The current manuscript attempts to address

this void by examining the following specific research question:

RQ1: What is the effect of the features of the communication channel on the

extent of learning by an individual knowledge recipient?

The pragmatist perspective, which we adopt in this study, also emphasizes the

role of the individual, reveling in their "splendid and multifaceted individuality"

(Seigfried, 1999, p. 85). Pragmatist scholars contend that each individual is different,

with varied preferences, and these "differences …must be respected," and also taken into

consideration in every possible inquiry. In addition, Szulanski (2000, p. 13), one of the

primary proponents of knowledge transfer, argues that "the attributes of the recipient are

... important." Thus, in this manuscript, we also examine the role of the individual

stakeholder's characteristics on knowledge transfer by examining specifically the

following research question:

RQ2: What is the effect of the recipient's characteristics on his/her extent of

learning?

We believe that the examination of the above two research questions will

constitute contributions to the existing literature for the following reasons: 1) Much of the

research on knowledge transfer has examined the phenomenon at the organizational or

team/unit level (e.g., Gupta & Govindarajan, 2000; Hansen, 2002; Hansen, 1999). While

these two levels of analysis are important, recent views in organizational research look

upon the *individual* as the ultimate *repository* and *user* of knowledge (e.g., Cook &

Brown, 2002) and therefore, it is important to understand knowledge transfer at the

individual level, which is the focus of the current study. 2) The extant literature has

categorized knowledge transfer as a two stage process, composed of *knowledge articulation and sharing* (from the source), and *knowledge internalization and learning* (by the recipient) (e.g., Davenport & Prusak, 1998). However, research studies in the area of knowledge transfer have primarily focused on the knowledge articulation and sharing phases (e.g., Gupta & Govindarajan, 2000; Hansen, 1999; Szulanski, 2000), giving limited attention to the knowledge internalization and learning phases. By examining the factors affecting *knowledge internalization by the recipient*, the current study attempts to address an important gap in this area. 3) Through its focus on the role of the features of the communication channel on individual learning, it not only contributes to the literature in knowledge transfer, but also in the area of human-computer interaction and computer-mediated communication where, as highlighted earlier, the impact of IT features on individual learning has received scant attention (Zhang & Li, 2005). (4) Finally, the theoretical basis of our media-related hypotheses, *Media Synchronicity Theory* (MST) (Dennis, Fuller, & Valacich, in press), has yet to undergo systematic theory testing, and this study is a first step toward that endeavor. Specifically, the manuscript provides guidelines as to how some of the channel characteristics proposed by MST may be operationalized, specifically informing researchers of an experimental strategy by which MST can be systematically examined in the future.

Next, we briefly review the theoretical bases that we draw upon in examining our research questions.

Theoretical Background

Knowledge Transfer

Knowledge transfer has been defined as the distinct movement of "complex routines" from a knowledge source to a recipient (Szulanski, 1996; 2000). Knowledge transfer is seen as a process where the source must 1) recognize the opportunity or need to initiate a transfer, and 2) then decide to transfer, or share the knowledge (Szulanski, 2000). The first steps of the knowledge transfer process thus encompass "the willingness of individuals in an organization to share with others the knowledge they have acquired or created (Gibbert & Krause, 2002)" (Bock, Zmud, Kim, & Lee, 2005). The next step involves the "reconstruction and adaptation [of that knowledge] at the receiving end" (Szulanski, 2000, p. 11).

The premise underlying much of the existing research is that once a sender has overcome a myriad of barriers to knowledge sharing, which may include motivational factors such as self interest/personal gain, expectation of reciprocal behaviors, organizational gain, and the organizational knowledge sharing climate, and actually shares some knowledge, the *intended recipient then becomes the focus*. In other words, researchers argue that it is as important to study the factors that influence the recipient's ability to internalize that knowledge, as it is to understand the factors affecting the source's ability to share knowledge. Given the emphasis of past studies on knowledge sharing by the source, in this study, we focus specifically on the recipient's knowledge internalization, which we describe in further detail below.

Recipient's Knowledge Internalization: A Pragmatist Perspective

Venzin, von Krogh, and Roos (2000) argue that before researching any issue related to knowledge, it is important to discover the epistemological roots, since "concepts take different forms depending on the epistemology they are based on." Similarly, Blosch (2001) also argues that without clearly stating "what constitutes knowledge" and knowledge transfer, "no form of enquiry can proceed, no technique or method of investigation … is self-validating," and therefore would make limited contributions to an organization's knowledge management efforts. In recent times, there have been attempts to clarify the meaning of knowledge and knowledge transfer by drawing on the American philosophical school of Pragmatism (Cook & Brown, 2002; Blosch, 2001).

There is confusion surrounding the origin of the pragmatism philosophy, but it is believed to have been nurtured and brought to the limelight in the late 1800s by philosophers such as Charles Peirce, William James, and John Dewey (Smith, 1999). At the heart of pragmatism are the concepts of "practice, purpose, and pluralism" (Stuhr, 1999, p. 33). Proponents of pragmatism argue that an issue/problem must originate in practice, and end in practice. As Smith (1999) argues, pragmatists turn their backs towards "abstraction and insufficiency, from verbal solutions," and embraces "concreteness and adequacy," and "turns… towards action" (Stuhr, 1999, p. 34). Pragmatists further emphasize that "practice is centrally and irreducibly purposeful," and therefore, 'take purpose seriously" (Stuhr, 1999, p. 38). Finally, pragmatists also value the principle of pluralism, arguing that any scholarly pragmatist inquiry must follow multiple paths in terms of methods or variables (Stuhr, 1999).

The pragmatist view of knowledge emphasizes that knowledge is "rooted in practice" and located "in action" (Blosch, 2001, p. 42). By focusing on the "practical outcomes," pragmatists suggest that "knowledge can be related to particular tasks and gathered and located accordingly" (Blosch, 2001, p. 46). In other words, knowledge is not something that one possesses, but also that which one does (Cook & Brown, 2002). Drawing on the pragmatist view of knowledge, recent researchers (e.g., Cook & Brown, 2002, p. 78) have suggested that *knowledge internalization* be viewed more as "knowing," which can only be understood through "concrete ... human action." This is in contrast to earlier views of knowledge internalization, which has typically viewed it as a form of learning (or absorption) by the recipient (Szulanski, 2000; Davenport & Prusak, 1998). Pragmatists specifically emphasize that in order to understand what a recipient has learned as a result of the transfer, it is not only important to assess what knowledge they "possess", but also to examine "what they do" or how they apply it (Cook & Brown, 2002, p. 79). Specifically, pragmatists focus on the meaningfulness of knowledge, and observe how "actors" are able to use it to "skillfully manipulate their environment" (Blosch, 2001, p. 46).

In this study, we draw upon the pragmatists view in understanding knowledge internalization and view it as both what actors "know or possess" (in other words, have "absorbed") as a result of the knowledge internalization process, and how they "apply" that knowledge. We believe that this is an important contribution, since prior research acknowledges that "improved practice" is not always the "product of acquiring more knowledge," but a result of "using knowledge already possessed" (Cook & Brown, 2002, p. 79). Further, this examination of knowledge application in addition to knowledge

possession goes beyond the traditional (and often limited) "static" view of knowledge. Finally, viewing knowledge internalization as being composed of different dimensions (i.e., "knowledge possessed," and "knowledge applied"), the study stays true to the pragmatist philosophy of "pluralism," which emphasizes the role of multiple paths in inquiry.

Channel Characteristics

Since the work of Shannon and Weaver (1949) in the area of signaling, prior research has consistently acknowledged that the communication channel has a significant effect on the effectiveness of the knowledge transfer. Drawing on this body of work, Szulanski (2000) argued that knowledge transfer would not only be affected by the characteristics of the source, the type of message being exchanged, and the context, but also by the characteristics of the recipient and the communication channel. On similar lines, Ma and Agarwal (2007) have argued that "IT-based features" affect the extent of knowledge contribution in online communities. Gal and Steinbart (1992) have also illustrated, through their empirical study, that the mode of communication channel used has a strong effect on the effectiveness of knowledge transfer and subsequent learning by the recipients.

While the above discussion establishes the close linkage between the channel and knowledge transfer/internalization, the key question that remains is: What type of a channel (or what characteristics of a channel) would positively affect knowledge internalization? To seek an answer to this question, and in developing our model, we turned to the media and channel characteristics literature.

Robert and Dennis (2005) argue that the two most prominent theories in the communication channel/media characteristics literature are the media richness theory (MRT), (Daft, Lengel, & Trevino, 1987; Daft & Lengel, 1986), and the social presence theory (Short, Williams, & Christie, 1976). According to the media richness theory, "communication media differ in their ability to facilitate understanding. Media can be characterized as high or low in 'richness' based on their capacity to facilitate shared meaning" (Daft et al., 1987, p. 358). The richness of each medium is based on four different criteria: extent of feedback offered, the number of cues supported by the channel, language variety, and personal focus. According to these criteria, face-to-face is considered the richest channel, and "formal, unaddressed documents" considered the most lean media (Daft et al., 1987). Previous literature examining the transmission channel and its impact on the extent of knowledge transferred has suggested that "richer transmission channels … [result] in greater success in knowledge transfer" (Kwan & Cheung, 2006; Daft & Lengel, 1986). However, in recent times, the "richness" concept has been criticized, with IS researchers rejecting the idea that richness is an "invariant, objective" property of the communication channel, and that higher use of a rich medium can have positive outcomes (e.g., Markus, 1994; Ngwenyama & Lee, 1997, p. 148). Several empirical studies examining the validity of the media richness theory "have not been favorable," (e.g., El-Shinnawy & Markus, 1998; Dennis & Kinney, 1998) with many of them establishing that managers' and other organizational members' communication channel choice, usage patterns, and their effect on outcomes are "inconsistent" with that proposed by the media richness theory (Ngwenyama & Lee, 1997, p. 147; Lee, 1994).

A number of other media theories have thus been proposed as alternatives to the media richness theory. The social presence theory was "originally devised to describe teleconferencing," and argues that the communication medium determines the degree of social presence ("or the feeling one has that other persons are involved in a communication exchange") in an interaction (Walther, 1995, p. 187-188). The theory further argues that "fewer the channels or codes available within a medium, the less attention is paid by the user to the presence of the other social participants," indicating that electronic medium which typically does not have multiple cues (visual or auditory) tend to have lower social presence than face-to-face medium (Walther, 1995, p. 188). While the theory has made an important contribution to the media and channel literature, its focus has been primarily on relational communication involving at least a dyad. In other words, it has mostly sought to understand how people use media to "define or redefine relationships" (Walther, 1995, p. 187), as opposed to how individuals internalize or learn new knowledge using a particular communication channel (the focus of the current study). Further, as Robert and Dennis (2005) highlight, both these above-mentioned theories (i.e., MRT and social presence), focus on rational media choice, and not on the effect of the media on outcomes.

Another theoretical perspective that addresses some of the limitations of the media richness theory is the channel expansion theory (Carlson & Zmud, 1999). This theoretical perspective argues that the concept of "richness of a media" is not constant (as argued by the media richness theory), but varies and depends on the experiences an individual (or dyad) have had in using this media. Carlson and Zmud (1999, p. 155) specifically argue that as individuals "develop experience communicating with others

using a specific channel… they may develop a knowledge base for more adroitly applying this communication channel." This "increasing ability to communicate effectively" through the use of a channel, would lead to the participants perceiving that channel as rich. Channel expansion theory brought the contextual element into the definition of richness of a media; however, its focus has still been on relational communication involving a dyad, therefore making it less suitable for our study. Other scholars have questioned the "richness" of the medium as being an important and valid characteristic, and have proposed alternative perspectives. Specifically, Kock (2005) has proposed the concept of "media naturalness," defined as the extent to which a particular communication channel supports the five components of natural face-to-face communication (i.e., synchronicity, body language, co-location, facial expression, and speech). Kock (2005) argues that media naturalness affects an individual's physical arousal and cognitive effort that one expends in a communication context. While the media naturalness perspective is novel, and makes an important contribution, its focus is again on relational communication, involving at least a dyad, which is different from the context of our study, where we attempt to understand the recipient's learning.

Continuing with the tradition of alternative perspectives to the concept of richness, the cognitive model of media (Robert & Dennis, 2005) combines the tenets of the social presence theory and the media richness theory to propose the paradox of richness. This theoretical perspective argues that high social presence is not necessarily a strength, but can have both positive and negative effects. Specifically, a high social presence media may lead to high motivation, but may decrease individual's ability to process the necessary information, suggesting that too many cues available in a media

might cause distractions and miscommunication. While the cognitive model does not provide us with the theoretical paradigm that we can directly apply to understanding a recipient's knowledge internalization, it provides certain propositions that are relevant to our study. They are: 1) the importance of the communicator/recipient's ability to process the information in order to draw meaning from it (in other words, internalize it), and 2) that use of multiple cues or symbols does not necessarily lead to positive outcomes, since it can also work towards creating more confusion for the communicator.

Yet another perspective that questions the tenets of media richness theory, and reiterates the importance of the communicators' ability to process and prepare messages, is the work of El-Shinnawy and Markus (1998). They propose that individual's choice of media is not "governed" by the richness, but by the types of task it supports. Specifically, they argue that individuals tend to select a media which enables them to "retrieve" and prepare/process messages, and work effectively in groups. In their empirical study, they found that organizational members repeatedly selected text-based email as their preferred medium of communication, over voicemail, which is considered to be more rich. Again, while this perspective focuses on media choice, and thus is not relevant to our study, its overall message is relevant to our work.

A theoretical perspective that draws on much of the ideas proposed in the cognitive model, and the work of El-Shinnawy and Markus (1998), especially highlighting the importance of reprocessability, the role of symbol sets, among others, is the media synchronicity theory (MST). Dennis, Fuller, and Valacich (in press) propose MST arguing that the richness of the channel depends not only on its characteristics, but also on its "information processing capabilities." Furthermore, MST suggests that, in

addition to the channel's capabilities to convey information and allow communication participants to converge on a shared meaning (MST refers to these elements and conveyance and convergence), a variety of appropriation factors (e.g., the ability to process the information) will influence how the communicators adopt and use the communication channel (Dennis et al., in press). In other words, MST provides a more comprehensive model surrounding media characteristics, and the role of these characteristics on outcomes. Specifically, the medium-centric perspective of media richness theory (Daft & Lengel, 1987), the socio-centric perspective of the social presence theory (Christie et al., 1976) and channel expansion theory (Carlson & Zmud, 1999), and the contextual aspects of the cognitive model of media (Robert & Dennis, 2005) and the work of El-Shinnawy and Markus (1998) are incorporated into MST. Consequently, we adopt this theoretical perspective in examining the role of the communication channel characteristics on knowledge internalization. In addition, MST, in conjunction with prior research in knowledge transfer and the pragmatist paradigm, also guides us in our choice of relevant recipient characteristics that play a role in effective internalization.

Specifically, MST proposes the role of five channel characteristics that they argue would not only enable communicators' abilities to convey the necessary information, but also increase the recipients' ability to process and internalize that information. These characteristics are (1) Transmission Velocity (i.e., the time taken to receive feedback from the initiator of the communication), (2) Symbol Sets (i.e., the number of symbols supported by the media), (3) Parallelism (i.e., the number of parallel communication channels possible during any given time), (4) Reprocessability (i.e., the number of times

a recipient can review the message conveyed by the source) , and (5) Rehearsability (i.e., the extent to which the communication initiator can rehearse a message prior to sending it to the recipients) (Dennis et al., in press). Among these five characteristics, *symbol sets* and *reprocessability* have been argued to affect the recipient's *learning* (Dennis et al., in press).

Our review of the media literature suggests that MST (and the media characteristics proposed by this theory) provides an useful lens for examining our primary research question. MST incorporates the information processing capabilities of a channel within the dimensions/characteristics of the channel, making it suitable for our study, which focuses on the role of the channel on recipients' ability to process and internalize new information and knowledge. Further, MST has close theoretical linkages with Shannon and Weaver's (1949) communication theory, which has been the basis of much of the prior knowledge transfer research, and hence the current study. We thus draw on MST in examining the role of the communication channel on knowledge internalization. Given the acknowledged effect of symbol sets and reprocessability on recipient learning/cognitive internalization (e.g., Robert & Dennis, 2005; Dennis et al., in press), in this study, we focus on the role of these two characteristics only.

Recipient Characteristics

Szulanski (2000, p. 12) suggests that the two key recipient characteristics that affect knowledge transfer effectiveness is the recipient's motivation "to seek or accept knowledge from the outside" and their absorptive capacity, or "ability to utilize outside sources of knowledge."

Apart from Szulanski, a recipient's *motivation* to encode and internalize new knowledge has also been identified as an important factor in other prior research as well (e.g., Simonin, 2004; Hayes & Clark, 1985; Katz & Allen, 1982; Zaltman et al., 1973). Motivation or intent to learn is an entity's willingness to learn from a source, a partner, or even a collaborative environment (Simonin, 2004, p. 409). Specifically, motivation to learn "captures the degree of desire for internalizing… skills and competencies" from another (Simonin, 2004, p. 409). Motivation to learn affects the extent to which one internalizes new knowledge, while a lack of it "may result in procrastination, passivity, feigned acceptance, sabotage, or outright rejection in the... use of new knowledge" (Szulanski, 2000, p. 12). While the critical role of the recipient's motivation in knowledge transfer has been acknowledged in prior research, very few empirical studies (e.g., Simonin, 2004) have examined its effect. In fact, Kalling (2003) argues that the primary focus in the knowledge transfer empirical literature has been on cognitive factors such as causal ambiguity, ignoring factors such as motivation, which should be given a more prominent position in future empirical research involving knowledge transfer. We thus examine the role of motivation to learn on knowledge internalization in this study.

The recipient's *absorptive capacity* (e.g., Cohen & Levinthal, 1990) has also been argued to be one of the key factors affecting knowledge transfer (Szulanski, 1996; 2000). Absorptive capacity has its roots in the economic theories, and was originally introduced to examine the role of a firm's R&D on its economic performance (Deeds, 2001). However, the concept of absorptive capacity has increasingly been adopted into the individual-level knowledge transfer and learning literature as well. Absorptive capacity has been defined as the recipient's ability to "recognize the value, acquire, transform or

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assimilate, and exploit knowledge" from outside sources (Todorova & Durisin, 2007, p. 776-777). Absorptive capacity is an inherent property of the recipient which he/she may develop gradually. Greater absorptive capacity would enable the recipient to recognize what is new knowledge, and grasp that new knowledge better (Lane & Lubatkin, 1998). Other researchers (e.g., Matusik & Heely, 2005; Lane, Salk, & Lyles, 2001) have also argued that an entity's learning depends heavily on its absorptive capacity. Similarly, MST (Dennis et al., in press) also argues that an individual's ability to process information (which is enhanced through higher experience, training, and familiarity with the material) often play a moderating role on the relationship between communication media and outcomes. Given the criticality of absorptive capacity on knowledge internalization and recipient learning, we also sought to examine its role in this study.

Next, we present the primary hypotheses of the study.

Hypothesis Development

MST researchers (e.g., Dennis et al., in press) propose that the symbol sets provided by the channel and the reprocessability of a channel results play a role in the extent to which the user is able to process and internalize the information. Symbol sets is defined as the "height of the medium" or the number of ways in which information can be communicated, and includes both the dimensions of multiplicity of cues and language variety. The literature on the use of symbol sets seem to be divided in terms of actual effect of the number of symbol sets used on communication effectiveness. Dennis et al. (in press) argue that the number of symbol sets a medium can support, affects communication effectiveness in a variety of different ways. For example, a message

composed with verbal and non-verbal symbols may enable the sender to "include information beyond the words themselves when the message is transmitted." Further, a message conveyed through a medium with a variety of different symbols would also enable the receiver to process it more efficiently and effectively. In the computer-mediated communicated literature too, it has been acknowledged that visual symbols in addition to text-based symbols can often lead to the effectiveness of the communication (Walther, Slovacek, & Tidwell, 2001). On the other hand, some scholars argue that multiplicity of symbols within the same message may distract the user, or cause delays in decoding the message (e.g., Williams, 1977), thereby leading to less effectiveness. In the context of knowledge transfer, Ma and Agarwal (2007) suggest that the extent of cues available within the communication channel often positively affects the extent of knowledge transferred. Drawing on the tenets of MST, and the literature on knowledge transfer, it may be argued that new knowledge, when conveyed through a channel with multiple symbols (i.e., multiple symbol sets), would be processed and internalized more effectively by the recipient. We thus argue:

H1:   *The number of symbol sets of a channel will positively affect the extent of knowledge internalized by a recipient (both in terms of what they possess and how they apply it).*

Reprocessability refers to the "extent to which a message [or information] can be reexamined or processed again within the context of the communication event" (Dennis et al., in press, p. 26). Knowledge that can be reexamined by the recipient several times (i.e., high reprocessability), will not only result in the absorption of a higher volume of knowledge, but will also enhance the recipient's ability to process and apply that

knowledge. The role of repetition and ability to reexamine a message on the

internalization of the message, has been widely examined in the marketing literature. Law

(2002, p. 367) argues that provision of "additional processing opportunities to a

recipient" can increase his/her ability to better recall that message. Rethans, Swasy, and

Marks (1986, p. 51) argue that "repeated exposure" to a message or information content

provides the recipient "additional opportunity for attending to, thinking about, and

elaborating upon the message arguments." This repeated "additional processing

opportunity" then "enables the message recipient to realize the message arguments'

cogency," and favorably influences the recipients' internalization (and future application)

of the message content. Applying this logic to the context of our study, we argue the

following:

> H2: *The reprocessability of a channel will positively affect the extent of knowledge internalized by a recipient (both in terms of what they possess and how they apply it).*

Absorptive capacity of the recipient has often been associated with higher

knowledge transfer (e.g., Gupta & Govindarajan, 2000; Szulanski, 2000; Cohen &

Levinthal, 1990). Absorptive capacity has been defined as the recipient's "ability to

exploit outside sources of knowledge." Szulanski (2000, p. 12) argues that high

absorptive capacity demonstrates a recipient's readiness in "discarding old practices" and

building new ones, and in reaping "the rewards of a transfer" by applying the new

knowledge. From an empirical study involving 122 best practices within organizations,

Szulanski (1996) concluded that the lack of absorptive capacity hinders the transfer of the

best practices. High absorptive capacity enables recipients to "harness new knowledge,"

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absorb it, and use it to generate outputs (Tsai, 2001). Without absorptive capacity, it

would be difficult for recipients to learn new knowledge (Tsai, 2001). Similarly, Reagans

and McEvily (2003, p. 243) argue that absorptive capacity enables recipients to associate

new ideas with "what they already know," thereby, increasing their learning. MST too

emphasizes the importance of the communication receiver's ability to grasp the

information on the communication effectiveness. Drawing on the above, we argue that a

recipient's absorptive capacity will positively affect his/her perceptions about the extent

of the knowledge they internalized, and their ability to apply it.

> H3a: *The recipient's absorptive capacity will positively affect the extent of knowledge internalized (both in terms of what they possess and how they apply it).*

Apart from the direct role played by absorptive capacity, drawing on the

literature, we argue that it will also interact with the characteristics of the channel to

affect the extent of knowledge internalized, specifically, the recipients' ability to apply

that knowledge. The moderating role of absorptive capacity on the effect of the

communication channel is suggested by the *pragmatis*t view of technology, which

supports the perspective that technology does not "uniquely determine social

arrangements" (Hickman, 1999), and also by the MST (Dennis et al., in press).

Dewey, one of the primary proponents of pragmatism argued that technology does

not "have the last say." In fact, he considered technology to be "multivalent," in the sense

that it offers all sort of possibilities, but it is up to the individual who uses the technology

to make "the best of those possibilities," and then "rework them to increase their value"

(Hickman, 1999, p. 112-113). Further, the concept of the "pragmatist technology' argues

that even if the technology has superior qualities, the ability of the individual to draw out

the "energies" from the technology would significantly affect the extent to which that

technology would affect the formulation of actions by the user, and the effectiveness of

the actions (Hickman, 1999, p. 115). At the same time, MST researchers (Dennis et al., in

press) suggest that the media may sometimes "both enable and constrain behavior." The

constraining role of the media might be mitigated by other communication recipient

characteristics, such as their inherent ability to absorb that information (i.e., absorptive

capacity), often developed through their prior training, experience, and familiarity with

the material.

Drawing on the above, we contend that the effect of the channel on the knowledge

internalization would depend, in part, on the absorptive capacity of the recipient. A

recipient with high absorptive capacity may be able to overcome the limitations of a

channel with few symbol sets and low reprocessability, and apply their new knowledge

effectively. Similarly, an individual with low absorptive capacity may thwart the

effectiveness of a channel with multiple symbol sets and high reprocessability. We

capture our arguments in the following hypotheses:

> H3b: *Absorptive capacity and symbol sets will have an interactive effect on the extent of knowledge internalized by a recipient (especially, their ability to apply that knowledge).*

> H3c: *Absorptive capacity and symbol sets will have an interactive effect on the extent of knowledge internalized by a recipient (especially, their ability to apply that knowledge).*

As discussed earlier, motivation to learn has been identified as an important factor

affecting knowledge internalization. Motivation of the recipient has been viewed/defined

as either intrinsic or extrinsic (Bock & Kim, 2002), as learning intent (e.g., Simonin,

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2004), or as a more complex domain specific construct such as *motivation to learn.*

Bures, Amundsen, and Abrami (2002), suggest that an individual's motivation to learn is composed of an individual's subjective competence, perceived relevance of the material, task attractiveness, and valuing subject, or interest in the subject. Irrespective of how motivation is viewed or defined, Szulanski (2000, p. 12) argues that the recipient's lack of motivation not only leads to their "passivity" and "feigned acceptance" of the new knowledge they have received, but would also result in poor "use" or application of that new knowledge. Similarly, Simonin (2004) concluded from his empirical study that a higher learning intent or motivation has a significant positive effect on the effectiveness of the knowledge transfer process, and the extent of recipient learning. Kalling (2003, p. 121), through a case study of a transfer program of manufacturing knowledge at an organization, concluded that "the stronger the motivation to learn, the more likely it is that individuals will work harder on trying to learn and pick up new knowledge." Further, individuals with high motivation would then also be more willing to apply their new knowledge in other contexts to enhance their learning further. Thus, we argue:

> H4: *Motivation to learn will positively affect the extent of knowledge internalized by a recipient (both in terms of what they possess and how they apply it).*

We summarize the hypotheses and the relationships between the constructs in Figure 3.1.

Figure 3.1: Proposed Research Model and Relationships between the Constructs

Research Methodology

To conduct a preliminary test of the hypotheses, an experimental study using

student subjects, and involving the explicit manipulation of symbol sets and

reprocessability was conducted. Given that symbol sets and reprocessability had not been

tested in prior empirical research, we believed that an experimental study with a common

task, same experimental room, and similar background and experiences of the

participants, would enable us to not only manipulate these two channel characteristics,

but also remove the effect of other extraneous variables, and thereby, observe the sole

effects of these two variables on the outcomes of interest. Further, while the use of

student subjects has been criticized in prior research, it has also been argued that it is often preferred to use student participants (instead of "practicing managers") in investigating different issues, since managers are "influenced by their work environment and are likely to carry organizational or job-specific perceptions." This makes it difficult to identify and control "organizational influences," and thereby, tends to taint the results (Ruchala, 1999, p. 169).

Sample

The sample of our study consisted of 284 undergraduate students enrolled in an introductory MIS course (required for all business students) at a large US University. 33.4% of the participants were females, and 66.6% of the participants were males. Given our focus on understanding the effect of the communication channel, and recipient characteristics on knowledge internalization, we specifically chose an introductory course as our experimental setting, where participants had little a priori domain knowledge. This enabled us to closely observe the effect of our variables of interest, as opposed to other extraneous variables such as prior exposure to the topic.

Procedure

During the experimental sessions, participants were presented with an on-line tutorial on activity diagramming, and then were asked to complete an activity diagramming related task. We specifically chose "activity diagramming" for the following reasons: 1) It has been argued that a "key activity in systems analysis and design," a core focus of the IS discipline, is to create conceptual models in an effort to

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"increase analysts' understanding" of the business processes (Burton-Jones & Meso, 2006). Even though there are several different modeling techniques, the UML modeling language drawing on the object-oriented systems analysis, and including different diagrammatic techniques such as *activity diagrams*, *class diagrams*, etc. is fast "emerging as a de facto standard" (Burton-Jones & Meso, 2006, p. 39). Thus, use of this diagrammatic technique made the study both relevant to the IS discipline, and timely; 2) The participants in the study, most of whom were in their first university-level information systems course, were unlikely to have any prior knowledge on activity diagrams, thereby, removing the threat of this extraneous variable in affecting the results; 3) The pragmatist philosophy, with its focus on the "centrality of action" emphasizes the use of process and activity maps in organizations, since such maps "represent a physical view, which is how the organization actually implements its understanding of its reality" (Blosch, 2001, p. 45). Indeed, pragmatists argue that such maps are "candidates for process improvement initiatives," and should form the base of an "organization's knowledge" (Bosch, 2001, p. 44-45). Given our use of pragmatism as our theoretical scaffolding, the use of activity diagrams as our task enabled us to create a closer coupling between the theoretical and empirical aspects of our study.

The study was conducted in multiple sessions, and during the allotted course laboratory sessions. Upon arriving at their assigned course laboratory section, the participants took their seats at a computer terminal. After a short administrative presentation by the lab instructor, the researcher read a verbal instruction script to each section (roughly 30 individuals per section). The participants then reviewed, signed, and dated the informed consent forms. After consenting to participate, the participants were

provided a url, and asked to open the url using their respective computers. The web site presented them with an on-line tutorial on activity diagramming.

After completing the review of the tutorial, participants were given the narrative of a business process, and asked to draw an activity diagram to represent it (please see Appendix D). After completing the activity diagram, and turning in their solutions, participants responded to an online survey assessing the strength of the manipulations, their absorptive capacity, motivation to learn, and extent of knowledge internalized. Each experimental session lasted approximately 50-60 minutes.

Manipulations and Measurement of the Communication Channel Characteristics

A key issue in our empirical study was to select (and develop) an appropriate operationalization of symbol sets and reprocessability, our two key independent variables. Given that the MST constructs are yet to undergo empirical testing, and that our study involved a laboratory experiment, our intent was to start with a basic operationalization of these two constructs, especially the number of symbol sets (i.e., symbol variety) used. In the existing literature, particularly on knowledge management, symbol sets have been viewed as a form of physical representation (e.g., Amare & Manning, 2007; Sparrow, 1998). According to this body of literature, "words [or plain text] are symbols" (Sparrow, 1998, p. 51). For example, Bernsen (1994), in his categorization of the different types of symbolic representations, suggests that at the lowest level is language (e.g., written words, text), while pictures such as diagrams are at higher levels. Similarly, Sparrow's (1998, p. 59) taxonomy categorizes "simple" text as the first level of the "basic symbolic systems," and diagrams (consisting of boxes and

arrows) at a higher level as "graphical abstract representations." Peirce (1935), a noted communication theorist, has also argued that basic text should also be viewed as a form of symbol. Amare and Manning (2007) define "simple" or basic text as those consisting "minimal visual formatting only: punctuation between major phrases and white space between words." Amare and Manning (2007), drawing on Solomon (1995), further suggest that emphasized or formatted text represent higher level symbols than basic text, and may be considered as "visual rhetoric" similar to diagrams. To summarize, a review of the literature on representations suggested to us that a basic operationalization of symbol sets (and an appropriate starting point) would be to provide simple text with minimal punctuation, white spaces, etc. Since our objective in this study was to compare the effect of communication channels using a simple symbol set with those consisting of multiple symbol sets on the knowledge internalization effectiveness, and since most taxonomies of representation refer to different types of formatted text, and diagrams or pictures as being higher level symbols, we operationalized symbol sets as follows: 1) text-only with minimal punctuation and font, and 2) text (with added formatting) + diagrams.

Online activity diagramming tutorials manipulating symbol sets and reprocessability were created. Condition 1 consisted of multiple symbol sets and high reprocessability; condition 2 consisted of a single symbol set and high reprocessability; condition 3 consisted of multiple symbol sets and low reprocessability; and condition 4 consisted of a single symbol set and low reprocessability. The single symbol set condition presented the tutorial in a *text-only* format within *minimal punctuation*. The multiple symbol set condition presented the tutorial with the same text as the *text-only* condition,

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but also included *images* of the different components of activity diagrams, along with

bolded and underlined key words. See Figure 3.2 and Figure 3.3 for the symbol set

manipulations.

Figure 3.2: Single Symbol Set Condition

Tutorial

Activity Diagram Tutorial

What is an activity diagram?

In its basic form, an activity diagram is a simple and intuitive illustration of what happens in a business process workflow. Specifically, it shows activities, the sequence of activities, activities that can be done in parallel, and alternative sequences of activities, all using a modified type of box and arrow diagram.

You can use activity diagrams to visualize the processes of a business use case. A complete workflow description will have a basic flow, and one or several alternative flows.

Activity
The core symbol in an activity diagram is the activity state or activity. An activity is a state of doing something such as typing a letter, calling a friend, or ordering a product. As noted above, an activity diagram describes the sequence of activities while being able to represent activities that can be done simultaneously, and activities that occur after a decision is made.

The symbol used to denote an activity is a rectangle with a rounded left and rounded right side, with a verb phrase to denote the nature of the activity, such as "Place Order."

As one progresses through the diagram, arrows show the flow of the process. So, after placing the order, the next step might be to Fill the order, so another activity titled "Fill Order" would be connected by an arrow from the "Place Order" activity above it.

Parallel Activities
If parallel processes can occur after an activity, a Fork is the symbol used to denote the split of the flow into two or more simultaneous processes. The symbol used to denote a Fork is a short, bold horizontal line with an incoming arrow from the activity above it, and two (or more) outgoing arrows toward the subsequent activities or decisions. In our running example, if an order is placed, one flow may be to the "Fill Order" activity, while another may go to the "Send Invoice" activity, so the arrow leaving the "Place Order" activity would flow to the fork where it would split into two arrows, one for the "Fill Order" activity and one for the "Send Invoice" activity.

Decision
A decision, or Branch, may be required after an activity. The symbol for a branch is a diamond with the incoming arrow from the activity and outgoing arrows (called guarded transitions or Guards) to denote the possible decisions to be made.

Figure 3.3: Multiple Symbol Sets Condition

Reprocessability was manipulated either 1) by allowing participants to keep the

tutorial window open on the desktop as they worked on the activity diagramming task

(i.e., high reprocessability), or 2) by automatically disabling the browser's back button

and erasing the url after participants had covered the entire tutorial, such that participants

were unable to retrieve the tutorial for future review (low reprocessability) (see Figures

3.4 and 3.5). For the low reprocessability condition, participants were provided a warning

that once they "clicked on the next button," they would be directed to the experimental

task, and would not be able to review the tutorial anymore.

Figure 3.4: High Reprocessability Condition
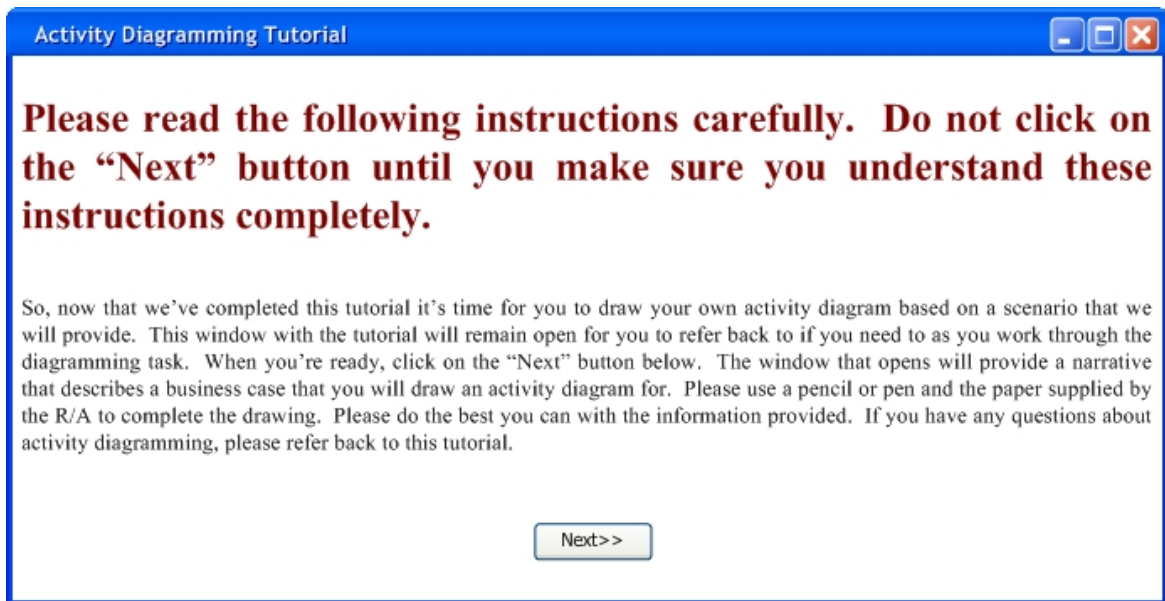
Figure 3.5: Low Reprocessability Condition

The program to administer the study was coded in a manner such that as participants logged on to their computers and visited the tutorial url, they would be automatically (and randomly) assigned to one of the four conditions mentioned earlier.

Measurement of the Other Variables

Prior research argues that measuring absorptive capacity is an "econometric challenge," since it is "unobservable" and therefore difficult to "measure directly" (Narasimhan, Rajiv, & Dutta, 2006). As a result, absorptive capacity has been measured using a variety of different methods. For example, at the organizational level, Lane and Lubatkin (1998, p. 468) have measured it as the "breadth of knowledge" captured by the "percentage of research communities associated with a scientific discipline in which a firm was active." Similarly, Leeds (2001, p. 39) measured absorptive capacity as "the number of research communities that a firm's scientists and engineers participate in." Others have measured it by observing the "efficiency with which a firm absorbs know-how from outside" (Narasimhan et al., 2006, p. 515). Szulanski (1996), one of the key proponents of knowledge transfer and its antecedents (including recipient absorptive capacity), and Szulanski, Cappetta, and Jensen (2004) have measured absorptive capacity using a number of different items administered either to the source or the recipient. Given our focus on knowledge internalization in this study, we measured absorptive capacity (of the recipients) using three items adapted from Szulanski et al.'s (1996) scale. We would like to note that prior research examining knowledge transfer at the individual-level (e.g., Ko, Kirsch, & King, 2005) have also drawn on Szulanski's scale for measuring the recipient's absorptive capacity.

The recipient's motivation to learn has also been measured using a variety of different techniques, though the dominant technique has been to administer an instrument capturing motivation to either the source or the recipient. Szulanski et al. (2004) measured recipient motivation using fourteen different items. Simonin (2004) measured motivation to learn using two different items administered to the recipient. Bures, Amundsen, and Abrami (2002) measured motivation to learn using an instrument capturing four different dimensions of motivation: subjective competence, personal relevance, task attractiveness, and valuing interest. Given the scale's focus on "motivation to learn," as opposed to general recipient motivation, and the fact that it captured a wide range of dimensions related to motivation, in this study, we used Bures et al's (2002) scale for measuring motivation to learn.

As discussed earlier, drawing on the pragmatist epistemology, we view the extent of knowledge internalized as both the knowledge "possessed," and the knowledge "applied." The extent of knowledge possessed as a result of a knowledge transfer has often been measured as a perception of the recipient. Simonin (2004) measured knowledge possessed using three different items that captured the extent to which an organization has learned about (and assimilated) the extent of technology and process know-how from the source. Szulanski et al. (2004) measured this critical construct as the accuracy with which the recipient reproduced the "replica of a template," the template being the new knowledge transferred to the recipient. At the individual-level, Ko et al. (2005) have measured knowledge possessed as the change in the knowledge base of the recipient due to the knowledge transfer process, and have captured it using self-reported items that were administered to the recipient. Other research at the individual-level (e.g.,

Joshi, Sarker, & Sarker, 2007; Sarker et al. 2005) have also measured knowledge transfer using multiple items. Following their guidelines, in this study, knowledge "possessed" was assessed using a perceptual measure, where participants (or recipients) responded to seven questionnaire items regarding the extent to which they have learned activity diagramming (four drawn from Ko et al. (2005) and Joshi et al. (2007), and three newly developed items).

Knowledge "applied" was measured by an objective assessment of the quality of the participants' activity diagrams. Such a technique of measuring recipient learning has been adopted in prior research as well. For example, Gal and Steinbart (1992, p. 135) had measured recipient learning by assessing "subject's performance on a test" after they had used a computer-assisted knowledge transfer program (referred to as CAT). Standard guidelines provided by prior researchers (e.g., Houston, Walker, Hutt, & Reingen, 2001) were utilized to assess the quality of the activity diagram solutions created by the participants. Specifically, two independent raters (neither of whom were associated with the research) rated each activity diagram. In assessing the quality (on a scale of 1 to 7), the raters provided scores on the following: a) completeness of the solution, b) correctness of the solution, and c) the overall quality. For the first 20 participants, the raters performed the coding jointly, to develop a common understanding of the coding procedure. For the rest of the participants, the raters coded the activity diagrams independently. The inter-rater reliability was found to be over .80, which is used as the established benchmark (Houston et al., 2001). The average of the two raters' ratings on each of the three dimensions was used as a measure of knowledge "applied." In other

words, knowledge applied was measured as a construct composed of three underlying sub-dimensions: completeness, correctness, and overall quality of the solution.

Please see Appendix E for the specific items of our measurement instrument.

Analysis Technique

First of all, to ensure that student participants were appropriately motivated to participate in the study, we conducted the mean value of our motivation to learn index. The results indicated that the mean value was roughly at the middle of the scale with appropriate standard deviation. In fact, on visual inspection, motivation to learn appears to be normally distributed within our sample (please see Figure 3.6), thereby alleviating this concern.

Figure 3.6: Results of the Analysis of the Motivation to Learn Index

PLS-Graph Version 3.00 was used to analyze the data. PLS has been shown to be a superior technique when it comes to analyzing interaction terms, and when the model has second-order factors (e.g., Chin et al., 2003; Lohmuller, 1989), and thus was appropriate for the current study which has a second-order factor (i.e., motivation to learn) and involves several moderating relationships (therefore, requiring the inclusion of interaction terms). Following the guidelines of prior researchers (e.g., Brown & Venkatesh, 2005; Gefen & Straub, 2005; Bhattacharya & Premkumar, 2004; Chin, Marcolin, & Newsted, 2003; Hulland, 1999), in the first phase, the validity and reliability of the measurement model was assessed, followed by an assessment of the hypothesized relationships.

For validating the scales we conducted a confirmatory factor analysis, which has been shown to be a preferred technique when the model has been developed by drawing on strong theoretical bases, and when using instruments that have been validated in prior studies. Chin (1998) suggests that when reporting results from an empirical analysis, researchers should provide the following information: item means, item loadings, structural paths and estimates, and r-square. We have followed these guidelines in reporting our results.

Prior research suggests that convergent validity of items can be established by satisfying the following three criteria: First, each item should load significantly on their respective constructs. While many researchers suggest that items should have a loading of .70 or above, others suggest that it is "often common to find that at least several measurement items in an estimated model" have loadings below the ".70 threshold, particularly when new items or newly developed scales are employed" (Hulland, 1999, p.

198). Researchers further suggest that items with loadings below .50 should be dropped. Second, the composite reliabilities should be greater than .70, and third, the average variance extracted (AVE) for each construct should be greater than .50). In this study, results indicated the following: 1) all items loaded significantly on their respective constructs, and most items had a loading above .70[2] (see Table 3.1); 2) the composite reliabilities of each of the items were above .70 (see Table 3.2); and finally, 3) the Average Variance Extracted (AVEs) of all the constructs were over the threshold value of .50 (see Table 3.2 which shows the square roots of the AVEs on the main diagonal). This established the convergent validity of the instruments.

Gefen and Straub (2005, p. 93) suggest that discriminant validity can be established by ensuring that the square root of the AVE of a construct exceed all correlations between that and any other construct within the study. In our study, the instrument validation results suggest that the square root of the AVE of each of the constructs in the study exceeded all correlations between that factor and other constructs within the study with one exception (see Table 3.2, which reports the square root of the AVEs of the constructs on the main diagonal, and the correlations between that construct and other constructs on the off-diagonal cells).The exception in this study is with the AVE for absorptive capacity, which is lower than the correlation between absorptive capacity and the subjective competence component of motivation to learn. However, further examination of the table suggested that the AVE for subjective competence is higher than the correlation between the two constructs, which suggests that discriminant

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[2] As suggested by prior research (e.g. Hulland 1999), items that had a loading of less than .50 were dropped, and the data was reanalyzed. As a result of this cut-off, one item measuring motivation to learn (valuing subject/interest) was dropped after the first-round of analysis.

validity of the two constructs may not be a concern. In order to further verify the discriminant validity of these two measures, we followed Gefen and Straub (2005, p. 93), who suggest that a more *sophisticated test* of discriminant validity involves the examination of the correlation between the latent variable scores with the measurement items, and ensuring that the measurement items load higher on their "assigned factor," than on any other factors. Consequently, we calculated the latent variable scores for each variable, and then observed the correlations of these scores with each of the items. Table 3.3 highlights that each of the items in our study has a higher correlation with their respective factors than with the other factors. While the items measuring absorptive capacity have a relatively higher correlation with the motivation to learn-subjective competence factor, they are still *lower* than their loadings on their respective factor (i.e., absorptive capacity), thereby confirming that absorptive capacity and motivation to learn-subjective competence are indeed two different constructs, and have adequate discriminant validity.

Table 3.1: Item Means, Standard Deviations, and Loadings

Item	Mean	Standard Deviation	Loading	Mean Loading
KTS1	4.23	1.34	.85	.85
KTS2	4.05	1.44	.85	.85
KTS3	4.14	1.65	.65	.65
KTS4	3.84	1.77	.69	.69
KTS5	4.37	1.57	.89	.89
KTS6	4.21	1.54	.83	.82
KTS7	4.30	1.56	.89	.89
KTO1	4.43	1.21	.87	.87
KTO2	5.40	1.29	.89	.89
KTO3	4.77	1.29	.99	.99
AC1	4.25	1.59	.71	.71
AC2	4.39	1.58	.78	.78
AC3	4.67	1.47	.79	.80
AC4	2.65	1.59	.54	.52
AC5	2.67	1.59	.57	.56
AC6	2.56	1.59	.58	.56
AC7	2.69	1.55	.64	.62
MTLPR1	4.45	1.57	.90	.90
MTLPR2	4.30	1.65	.89	.89
MTLPR3	3.29	1.65	.71	.69
MTLSC1	3.64	1.56	.86	.85
MTLSC2	4.21	1.52	.87	.87
MTLSC3	3.87	1.49	.93	.93
MTLSC4	4.32	152	.75	.74
MTLTA1	3.56	1.67	.83	.83
MTLTA2	3.14	1.52	.91	.91
MTLTA3	3.26	1.59	.92	.92
MTLVS1	4.46	1.75	.76	.75
MTLVS2	3.96	1.68	.86	.86
MTLVS3	4.98	1.53	.72	.72
MTLVS4	4.69	1.66	.79	.78

Table 3.2: Composite reliabilities, Correlations between the Constructs, and AVEs of the Constructs

	Construct	Composite Reliability	1	2	3	4	5	6	7	8	9
1	KT (Subjective)	.930	**.812**								
2	KT (Objective)	.942	.323	**.919**							
3	Absorptive Capacity	.846	-.637	.169	**.668**						
4	Motivation to Learn (Subjective Competence)	.914	.513	.213	.706	**.854**					
5	Motivation to Learn (Personal Relevance)	.876	.307	.078	.228	.227	**.839**				
6	Motivation to Learn (Task Attractiveness)	.918	.467	.185	.416	.428	.582	**.888**			
7	Motivation to Learn (Valuing Subject/Interest)	.864	.172	-.079	.160	.101	.454	.315	**.784**		
8	Symbol Sets	1.00	.305	.401	.319	.224	-.028	.100	-.111	**1.00**	
9	Reprocessability	1.00	.132	.125	.110	.042	.009	.043	-.090	.104	**1.00**

Note: Square roots of AVE are presented in bold on the diagonal, with off diagonals highlighting the correlations between the constructs.

Table 3.3: Correlations between the Items and the Constructs

	Symbol variety	Reprocess-ability	kt_sub	kt_ob	Constructs Abs-capacity	mtlpr	mtlsc	mtlta	mtlvs
symbol_variety	**1.00**	0.10	0.31	0.40	0.27	-0.03	0.22	0.10	-0.11
reprocessability	0.10	**1.00**	0.13	0.12	0.11	0.01	0.04	0.04	-0.09
KT_sub1	0.28	0.16	**0.85**	0.31	0.52	0.28	0.43	0.42	0.13
KT_sub2	0.29	0.11	**0.84**	0.26	0.55	0.27	0.44	0.43	0.15
KT_sub3	0.18	0.06	**0.65**	0.23	0.38	0.28	0.25	0.24	0.16
KT_sub4	0.18	0.03	**0.69**	0.20	0.57	0.14	0.54	0.36	0.05
KT_sub5	0.27	0.19	**0.89**	0.32	0.61	0.26	0.40	0.41	0.16
KT_sub6	0.24	0.06	**0.83**	0.21	0.59	0.29	0.37	0.36	0.23
KT_sub7	0.27	0.14	**0.90**	0.30	0.61	0.24	0.44	0.39	0.12
KT_ob1	0.30	0.14	0.24	**0.87**	0.15	0.07	0.08	0.12	-0.07
KT_ob2	0.32	0.09	0.31	**0.90**	0.25	0.07	0.25	0.20	-0.08
KT_ob3	0.46	0.12	0.33	**0.99**	0.25	0.08	0.23	0.19	-0.07
ac1	0.24	0.07	0.63	0.23	**0.76**	0.25	0.45	0.38	0.11
ac3	0.21	0.12	0.49	0.15	**0.82**	0.15	0.56	0.26	0.18
ac4	0.21	0.08	0.52	0.18	**0.86**	0.19	0.67	0.31	0.19
mtlpr1	-0.06	-0.01	0.26	0.06	0.22	**0.90**	0.17	0.41	0.42
mtlpr2	-0.07	0.00	0.28	0.07	0.26	**0.90**	0.22	0.42	0.44
mtlpr3	0.06	0.03	0.23	0.07	0.14	**0.70**	0.18	0.64	0.28
mtlsc1	0.21	0.06	0.44	0.16	0.55	0.16	**0.86**	0.42	0.01
mtlsc2	0.19	0.08	0.48	0.17	0.64	0.19	**0.87**	0.39	0.12
mtlsc3	0.24	0.03	0.48	0.19	0.66	0.19	**0.93**	0.38	0.07
mtlta1	0.08	0.10	0.42	0.22	0.34	0.62	0.36	**0.83**	0.31

mtlta2	0.12	0.04	0.41	0.12	0.37	0.44	0.37	**0.91**	0.26
mtlta3	0.07	-0.03	0.42	0.15	0.35	0.49	0.40	**0.92**	0.27
mtlvs1	-0.06	-0.07	0.09	-0.08	0.07	0.43	0.00	0.23	**0.76**
mtlvs2	-0.09	-0.12	0.18	-0.05	0.23	0.38	0.18	0.37	**0.86**
mtlvs3	-0.09	-0.04	0.17	-0.02	0.20	0.32	0.06	0.16	**0.72**
mtlvs4	-0.10	-0.04	0.09	-0.10	0.08	0.30	0.05	0.19	**0.79**

In the following phase of the analysis, the significance and strength of the hypothesized relationships were examined. To test the moderating effects, interaction terms were created following the product-indicator approach suggested by Chin et al. (2003). Chin et al. (2003) suggests that each indicator of the moderator variable should be multiplied with each and every indicator of the predictor variable to create product indicators. These product indicators would be reflective of the latent interaction variable. Chin et al. (2003, p. 2003) cautions researchers that "one important step in undertaking the PLS product-indicator approach is to decide whether indicators must be standardized or centered." Miles and Shevlin (2001) suggests that when the interaction involves two continuous variables, the data (of both the variables) should be standardized, while in an interaction involving a continuous and a categorical variable, the continuous variable should be centered. Finally, for an interaction involving two categorical variables, a simple product term needs to be calculated. Based on the above suggestions, appropriate product indicators (after standardization or centering wherever relevant) were created and entered into the path analysis. Results of the path analysis, including the path coefficients, path significances, and the variance explained for each endogenous variable are shown in Figure 6.

The second-order factor of motivation to learn was modeled using a "molecular approach." This approach suggests that "an overall latent construct exists and is indicated by the first order constructs" (Chin & Gopal, 1995, p. 49-50). In this study specifically, the molecular approach suggests that our second order factor (i.e., motivation to learn) is indicated by the relevant first order constructs (valuing interest, etc.). To test our

hypotheses, we created a hierarchical component model using repeated manifest variables (to address the issue of second-order factors), following the guidelines of Chin et al. (2003) and Lohmoller (1989). Specifically, the manifest variables for the four dimensions of motivation to learn were included twice: once for each of the four dimensions, and once for the second order factor. All of the path coefficients from Motivation to Learn to its four dimensions were high, with coefficients ranging from .59 to .84. This suggested that "motivation to learn" was indeed indicated by the underlying first order factors.

To assess the strength of the manipulations, we administered two items to the participants, one for each manipulation. Results indicated that there was a high and significant correlation between the participants' assessments of the manipulations and the actual manipulations (symbol sets: $r = .376$, $p < .01$, reprocessability: $r = .299$, $p < .01$).

Results provided strong support for most of the hypothesized relationships in the model. Symbol sets had a significant effect on both measures of knowledge internalization (knowing and applying) (see Figure 3.7). On the other hand, reprocessability had a marginal effect on both measures of knowledge internalization, with the relationships significant at $p < .10$. Participants' perceptions about their absorptive capacity significantly affected their perceptions of knowledge "possessed," but failed to have an effect on their application of that knowledge. Further, as hypothesized, motivation to learn had a significant effect on both measures of knowledge internalization. Overall, the variance explained by symbol sets, reprocessability, absorptive capacity, and motivation to learn on the two measures of knowledge internalization were 52.4% and 23.3% respectively (See Figure 3.7). Finally, as hypothesized, absorptive capacity had a significant moderating effect on the relationship

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between symbol sets and knowledge application. However, the predicted moderating effect of absorptive capacity on the relationship between reprocessability and knowledge application was not supported.

Figure 3.7: Model with Path Coefficients and Variance Explained in the DVs
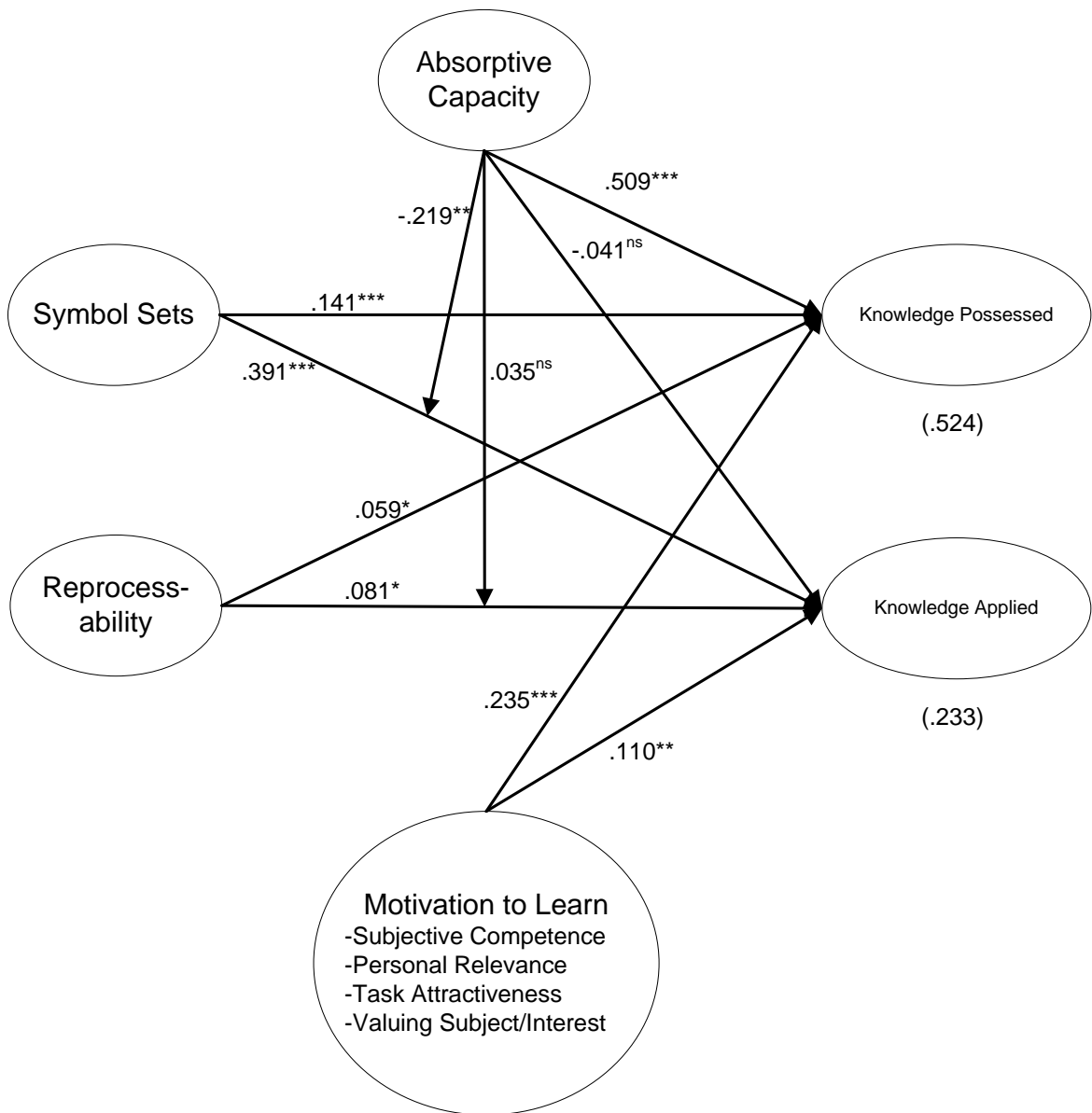
Discussion

The results of the empirical study suggest that symbol sets and motivation to learn each have a significant effect on both dimensions of knowledge internalization (i.e., knowledge possessed and knowledge applied). Further, as hypothesized symbol sets and absorptive capacity positively interacted to affect recipients' knowledge application. The role of reprocessability as an independent variable was marginally supported, and in interaction with absorptive capacity was not supported. One possible reason for this marginal effect of reprocessability could be due to the fact that there was little time delay between the presentation of the knowledge to the participants and their performance of the task. This lack of a time gap could have led to little (or no) deterioration of the encoded knowledge, even for those who were in the low reprocessability condition, and therefore could have contributed to the lack of a significant difference in the knowledge application between those exposed to the high reprocessability condition versus those in the low reprocessability condition. Weick (1985) also argues for the important role of time in recipient learning. He suggests that people learn slowly, and through a "careful reasoning during which they formulate ideas and reach conclusions." With time, recipients' "partially formed connections" between old and new knowledge are "allowed to incubate and become clarified… later events are used to reinterpret earlier ones," and together this leads to enhanced learning, and an increased ability to apply this new knowledge. Drawing on this, we believe that the effect of reprocessability will become more pronounced after a time delay between the presentation of this new knowledge and the application of this knowledge in a task. During this time delay, those in the high reprocessability condition, owing to them being exposed to a larger content of

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information, would be better able to make the necessary connections between the old and new knowledge, and thus retain more of the knowledge than those in the low reprocessability condition.

The lack of a strong effect of reprocessability could also be understood by drawing on Weick's (1985) concept of "cosmology episodes." The concept of "cosmology episodes" was developed to understand why "electronic processing has made it harder, not easier, to understand events that are represented on screens" (Weick, 1985, p. 51). Weick (1985) specifically argued that electronic information sharing often tend to create overloads (i.e., a state where the recipient gets "too much of the same kind of information"). This repetitive information results in a "cosmology episode," where recipients simply process the information without any conscious attempts at internalizing it (Gal & Steinbart, 1992; Weick, 1985). In fact, it has been argued that such cosmology episodes are "dysfunctional to learning" (Gal & Steinbart, 1992, p. 132). In the context of this study, such a negative effect of the cosmology episodes may have taken place, where due to the ability to continuously reprocess the knowledge regarding activity diagrams, recipients may have just resorted to viewing that information, without significantly processing it, and therefore being unable to apply it adequately in the activity diagramming tasks that followed the tutorial.

Contrary to expectation, absorptive capacity did not have a significant effect on the application of new knowledge. Given that absorptive capacity refers to not only the ability to value and assimilate new knowledge, but also the ability to "apply it to achieve.. objectives," (Lane & Lubatkin, 1998, p. 464), this result was unexpected. It could be that even though participants had the ability to apply the knowledge, they failed to do so

owing to their lack of motivation and objectives. This suggests that there could potentially be an interactive effect of absorptive capacity and motivation apply relevant knowledge, and this relationship needs to be examined in future research.

Contributions

Overall, we believe that the study makes some significant contributions to both the literature on user-computer interaction and knowledge transfer. Specifically, the study informs prior and limited research on the role of channel and recipient characteristics on knowledge transfer in the following ways:

It draws on more contemporary literature on channel characteristics (that rejects the idea that media is "monolithic" in terms of its richness), and illustrates the effect of media characteristics (that encompass both its objective characteristics and its information processing capabilities) on knowledge internalization, which we believe, has not been examined before.

Prior literature has examined knowledge internalization by focusing on the extent to which an individual "knows" (or possesses knowledge about) a particular material. This study, adopting the pragmatist philosophy, takes a step forward, and focuses on "knowledge application" in addition to knowledge "possession." The results suggest that knowledge application is much different from knowledge possession, and highlights that for complete knowledge internalization, it is not only important for an individual possesses the relevant knowledge, but also to seamlessly apply it in other contexts. This finding, we believe has important theoretical and practical ramifications.

Related to the above issue, and remaining true to the pragmatist philosophy of "pluralism," our study also sought to examine the role of the independent variables on two different dependent variables, or components of knowledge internalization. This we believe is an important contribution, since much of the prior studies on knowledge transfer studies has typically focused on one specific dependent variable only (i.e., knowledge transferred or gained).

Further, the study's focus on the critical role of the dimensions of the IT interface (i.e., symbol sets and reprocessability) on the knowledge recipient's learning makes an important contribution to the rich body of HCI literature, where the impact of IT on individual learning has received very little attention (Zhang & Li, 2005).

We also believe that this study offers a foundation for future research, especially in the domain of communication channel characteristics. While the theoretical concepts of MST have been acknowledged within the IS discipline, there are no known empirical studies that have specifically manipulated the characteristics proposed by MST, and examined their effects. We believe that this study provides an illustration of how the characteristics proposed by MST (especially, symbol variety and reprocessability) may be manipulated, and therefore empirically tested.

Finally, existing literature seems to be divided regarding the role of symbol variety on communication outcomes, with some scholars arguing for a positive effect of the number of symbol sets used on communication outcomes (e.g., Walther et al., 2001), with others arguing that too many symbols tend to cause distractions for the recipient, and therefore lead to lower effectiveness (e.g., Williams, 1977). Still others suggest that the role of symbol sets is contextual, depending on the nature of the task being

performed. Based on a <u>controlled</u>, <u>empirical</u> analysis, our study indicates, in line with the work of Ma and Agarwal (2007), that in the context of knowledge internalization, multiple symbol sets can work positively, thereby contributing toward a resolution to this debate.

Practical Implications

We believe that our study results in some important practical contributions, especially in the context of knowledge acquisition, learning, and online or e-training in organizations. Both researchers and practitioners suggest that one of the most "productive and readily accessible" means of acquiring new knowledge in organizations is through interpersonal communication channels such as face to face communication with colleagues (Dewhirst, 1971). However, recent literature and anecdotes from practice seem to indicate that while such channels might be easier to access, individuals often avoid it due to the "psychological cost," and fear of "making a partial admission of the intellectual superiority of that colleague" (Dewhirst, 1971, p. 307). Consequently, there has been an increasing trend in the maintenance of electronic knowledge systems, albeit with some reservations, with the objective of fostering knowledge sharing and learning by organizational members. Our study indicates that in the presence of appropriate recipient characteristics and channel features (symbol sets and reprocessability), organizations may be able to enable the absorption of new knowledge and its application by organizational members, without having them to incur psychological costs of seeking more knowledgeable colleagues.

The results of our study also have important implications for professional communicators. In today's digital age, professionals often need to communicate using the electronic media. Further, different knowledge sharing/acquisition forums (e.g., communities of practice) exist over the electronic media (i.e., the Internet). While current technologies enable the use of multiple symbols, it must be acknowledged that much of this knowledge acquisition/internalization still takes place through the use of text or written chat sessions (e.g., Lesser & Fontaine, 2004). While our results show that low symbol variety has a negative effect on knowledge internalization, we believe that it should not be viewed as disheartening for professional communicators or knowledge recipients. The results of our interaction analysis suggest that high absorptive capacity of the recipient can overcome the challenges posed by a media with low symbol sets, and still result in high knowledge internalization. It is thus important for professional communicators, who often find themselves having to communicate (and facilitate the knowledge internalization of other recipients) using a medium with low symbol variety, to positively nurture the absorptive capacity of their recipients, either by exposing them with supplementary material on the topic, or even by offering continuous exposure to the necessary material (such that recipients are able to reprocess it several times), in an effort to enable them to grasp, internalize, and put into practice new knowledge efficiently and effectively.

A final practical implication that our study provides, for organizational members in general and professional communicators in particular, is that there is a difference between what new knowledge one possesses, and whether he/she is able to apply that new knowledge in a relevant context; in the words of Cook and Brown (2002, p. 78)

whether the individual is able to transform that knowledge into "concrete ... human action." Often times, an individual might have been able to absorb a level of knowledge, but may fail to apply (or use) it effectively when the need arises. Since for organizational members, action and application is of utmost importance, and given our results, we believe that professional communicators (who are agents for disseminating new knowledge such that certain organizational outcomes can be achieved) should not only ensure that their knowledge has been successfully absorbed by the recipient, but also make sure that the recipients are able to apply it effectively. In other words, it is not advisable for them to take for granted the success in knowledge transfer until they are confident that the recipients of their communication (i.e. knowledge sharing) been able to successfully apply this knowledge in other contexts. Similarly, recipients should understand, that simply possessing knowledge is not enough, and they should continually strive to ensure that they are able to apply that new knowledge in other contexts. It is only through this *application* that knowledge internalization would be complete.

While we are excited about the contributions, we must acknowledge that like all other studies, this investigation also has some limitations, which we discuss below.

Limitations

One of the potential limitations arises from the fact that respondents provided assessments of the predictor (e.g., absorptive capacity and motivation to learn) and the criterion variable (i.e., knowledge possessed) at the same time, and after completing the tutorial and the experimental task. While this is not an uncommon practice, recently, some researchers have raised common method variance (CMV) concerns regarding such

studies (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). While our study could have potentially been affected by CMV, we believe that it is not a concern here, due to the two following reasons: 1) the use of established instruments (as in this study) reduces the threats associated with CMV (Podsakoff et al., 2003); and 2) We conducted the widely-known Harmon's single-factor test to check for CMV (e.g., Bhatt & Grover, 2005; Podsakoff et al., 2003), which indicated that CMV was not a major problem. Further, our confirmatory factor analysis, viewed as a "sophisticated test" of CMV (Podsakoff et al., 2003, p. 889), also revealed that the items had higher loadings on their respective factors (as opposed to other factors).

Another potential limitation of the study could be the use of student subjects in an introductory MIS course, the majority of whom had little (or no prior) knowledge of business process modeling or activity diagrams. While this lack of prior knowledge enabled us to enforce strict experimental controls, it could have also hindered their ability to absorb the new knowledge and apply it independently to accomplish a task. Given that existing research has often emphasized the importance of prior related knowledge on recipient's ability to apply that knowledge, future research using more senior students or organizational members could help enhance confidence in the validity of the results from this study.

Finally, in this study, in the interest of maintaining strict experimental controls, we adopted a fairly basic operationalization of symbols sets (i.e., simple text with minimal punctuation, and text (with added formatting) + diagrams). This simple operationalized may have reduced the practical relevance of the study. However, prior literature has indicated (e.g., Lee, 1994), that simple text can also be evocative and rich.

Lee (1994, p. 154), specifically states that through "distantiation, autonomization, social construction," text can convey a "world of meaning," which is much more than the simple "dictionary definition of the words in which it was written." Others have also argued that the use of text only, necessarily does not lead to inferior results (e.g., Sparrow, 1995). Finally, much of organizational knowledge acquisition, and communication still today occurs through the use of written text (memos or email). For example, Lesser and Fontaine (2004) suggests that "online chats with experts" are very commonly offered by technology organizations (e.g., SAP) today, and are regularly used by customers for knowledge acquisition about (or to learn) a new tool. Since such "synchronous chats" often do not provide anything but simple textual symbols, we believe that our basic operationalization of symbol sets simulates such situations, and thus, does not necessarily lack in relevance.

Future Research

We believe that our study points to several avenues for future research. As discussed earlier, our results indicated a weak effect of reprocessability, with prior research suggesting that the lack of significant time between when individuals were provided the information and when learning was assessed could have contributed to the result. Future research can introduce a time delay between knowledge conveyed to a recipient and his/her recall of that knowledge, and assess the role of reprocessability longitudinally.

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Further, in this study, we only examined the direct effect of motivation to learn on knowledge internalization. Future research could also involve an examination of the role of motivation as a moderator of the relationships between symbol sets and reprocessability and knowledge internalization, and between absorptive capacity and knowledge internalization.

Finally, in this study we introduced some basic manipulations of symbol sets (i.e., text only, and text (with added formatting + images). Future research could introduce additional symbol sets (e.g., voice in addition to text and images vs. only text and images), and compare the effect of those complex sets of symbols on knowledge internalization. Given that prior literature suggests that the use of multiple and complex symbols can cause delays in decoding, and thereby lead to confusion and distractions on behalf of the user (e.g., Williams, 1977), it may be interesting to examine whether the addition of complex symbols (such as the ones mentioned above) leads to higher or lower knowledge internalization. In any case, there is much to be learned about knowledge internalization, particularly as it pertains to individuals, and we hope this study contributes significantly in this direction.

CHAPTER FOUR

ESSAY 3

Performance and Recall: Media Capabilities'

Effects on Communication Effectiveness Over Time

Introduction

With the diffusion of multitudes of communication technologies (e.g., e-mail, instant messaging, teleconferencing, asynchronous discussion forums) across organizations, research on communication media characteristics and their effects on communication effectiveness have resulted in ambiguous findings (c.f., Robert & Dennis, 2005; El-Shinnawy & Markus, 1998; Dennis & Kinney, 1998). Much of this research has examined communication effectiveness through the lens of Media Richness Theory (MRT) (Daft & Lengel, 1986), and still others have developed alternative theoretical approaches with which to examine media effects on communication performance, such as Social Presence theory (Walther, 1995), Channel Expansion theory (Carlson & Zmud, 1999), and Media Synchronicity theory (MST) (Dennis, Robert, & Valacich, in press). While empirical tests have generally shown some advantages to the social presence and channel expansion theoretical approaches, they have focused more on the relationships between the communicators and/or the relationships between the communicators and the medium itself, rather than on media capabilities and their downstream effects. MST, however, proposes a theoretical framework that incorporates both a techno-centric, and a socio-centric view, and has received little empirical examination (see Essay 2).

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The purpose of this essay is to continue to build upon the empirical testing that was carried out in essay 2. That is, essay 2 developed an experimental strategy with which several aspects of MST can be tested. This essay uses that strategy, but also incorporates a time, or longitudinal component. In essay 2, symbol sets and reprocessability were manipulated, absorptive capacity and motivation to learn were measured, and performance was assessed using both a self-report of knowledge internalized and an objective assessment of drawings that were completed by the study participants immediately following a tutorial on activity diagramming. In the current study, the experimental procedures were replicated, but some changes were made based on insights gained from essay 2 and reviewer comments provided on essay 2. While reprocessability was manipulated in the same manner, a more controlled measurement of reprocessability was used. Also, in addition to collection of the subjective and objective dependent variables at the time of the tutorial, the study participants returned 14 days later and completed another drawing task to incorporate a longitudinal component to this research.

This essay is organized in the following sections. In the next section, the theoretical basis for impact of time on knowledge retention and recall is presented. Hypotheses are derived in the following section, followed by a description of the experimental procedures. Results are presented next and, finally, discussion and implications are provided.

Theoretical Background

In building upon and replicating Essay 2, this essay depends heavily on the theoretical arguments presented in Essay 2. Specifically, this essay uses the same conceptual foundation in MST and recipient characteristics (i.e., absorptive capacity and motivation to learn) to develop the research model for this study[3]. In addition to replicating essay 2, this essay incorporates a longitudinal component to examine how the passage of time influences the recipient's ability to perform based on a message they received some time in the past.

Retention and Forgetting Over Time

Research on knowledge retention and forgetting has been ongoing for over one hundred years. Over that time span, a variety of theoretical approaches to examine the nature of human learning and retention have been advanced (Rubin & Wenzel, 1996). Common across these various theoretical approaches, however, is the general nature of human retention. That is, humans' ability to retain information after exposure to that information decreases over time. Many of the theoretical distinctions between the various approaches to the study of retention is with respect the shape of the curve that describes the decrease in ability as time passes. In their review of research on retention and forgetting, Rubin and Wenzel (1996) identify four functions that describe the published data on retention. Although there are important distinctions between the functions and how they influence the interpretation of the data, for the purposes of this

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[3] For a detailed discussion of the theoretical background for this essay, please see Chapter 3, pages 24 – 33.

study, I am concerned with the consistency of the shape of the functions over time. That is, very soon after exposure to some information with little or no effort at boosting retention (e.g., practice), retention fades quickly, then levels out and the ability to remember the information approaches randomness over long periods of time.

To reverse the forgetting phenomenon, or to increase retention over time, research consistently advocates practice of, and repetition with, the source material. That is, the more often the individual processes the information, the more likely they are to remember it at a later time (Bromage & Mayer, 1986).

Hypothesis Development

Consistent with the hypotheses developed in Essay 2, the research model in this essay replicates the hypotheses tested in Essay 2 with two exceptions. In addition to the direct effects of symbol sets, absorptive capacity, and motivation to learn on both facets of knowledge internalization, knowledge possessed and knowledge applied, and the interaction of symbol sets with absorptive capacity and motivation to learn on knowledge applied, this essay proposes a refinement to the hypothesis regarding the effect of reprocessability on both faces of knowledge internalization, and an interaction between motivation to learn and symbol sets and reprocessability on knowledge applied. To summarize, the following hypotheses are replicated from Essay 2:

H1:   *The number of symbol sets of a channel will positively affect the extent of knowledge internalized by a recipient (both in terms of what they possess and how they apply it).*

H3a: *The recipient's absorptive capacity will positively affect the extent of knowledge internalized (both in terms of what they possess and how they apply it).*

H3b: *Absorptive capacity and symbol sets will have an interactive effect on the extent of knowledge internalized by a recipient (especially, their ability to apply that knowledge).*

H3c: *Absorptive capacity and reprocessability will have an interactive effect on the extent of knowledge internalized by a recipient (especially, their ability to apply that knowledge).*

H4a: *Motivation to learn will positively affect the extent of knowledge internalized by a recipient (both in terms of what they possess and how they apply it).*

As noted in Essay 2, reprocessability refers to the "extent to which a message [or information] can be reexamined or processed again within the context of the communication event" (Dennis et al., 2008, p. 26). Knowledge that can be reexamined by the recipient several times (i.e., high reprocessability), will not only result in the absorption of a higher volume of knowledge, but will also enhance the recipient's ability to process and apply that knowledge. The role of repetition and ability to reexamine a message on the internalization of the message, has been widely examined in the marketing literature. Law (2002, p. 367) argues that provision of "additional processing opportunities to a recipient" can increase his/her ability to better recall that message. Rethans, Swasy, and Marks (1986, p. 51) argue that "repeated exposure" to a message or information content provides the recipient "additional opportunity for attending to, thinking about, and elaborating upon the message arguments." This repeated "additional processing opportunity" then "enables the message recipient to realize the message

arguments' cogency," and favorably influences the recipients' internalization (and future application) of the message content. The results of Essay 2 found marginal support with low path weights for the effect of reprocessability on both facets of knowledge internalized. Considering the experimental procedures, I propose that the collection of the DV immediately following presentation of the information to be learned created a ceiling effect where the difference between high and low reprocessability participants could not be differentiated.

Ruben and Wenzel (1996) compiled evidence from over 200 data sets that suggests that with the passage of time, the ability to recall information decays quickly in the short term. As time continues to pass, the decay occurs less quickly, but the relevant issue is that retention is negatively affected with the passage of time. In combining the argument presented above that increased processing, in the form of repetitive processing of the message increases retention, coupled with the decay of retention over time, I hypothesize that the effect of reprocessability will emerge after a delay, where those with the opportunity to process the message multiple time will experience less decay of retention ability over time. Likewise, those with minimal opportunities to process the message will experience more decay of retention ability over time. Thus, I hypothesize:

H2: *The reprocessability of a channel will positively affect the extent of knowledge internalized by a recipient (both in terms of what they possess and how they apply it), and will have a stronger effect following a time delay.*

In a situation where no interventions are introduced between the initial exposure to the message and a retention test, symbol sets, absorptive capacity, and motivation to learn should show weaker effects after a time delay. Following the logic of Ruben and

Wenzel (1996), I hypothesize that the effects of symbol sets, reprocessability, and motivation to learn will have a positive effect on knowledge applied at time 2, however that effect will be weaker than the effect at time 1.

A weakness identified in Essay 2 was that testing of an interaction effect between motivation to learn and the media capabilities was not considered or carried out. As Dennis et al., (in press) argue, media capabilities effects on communication effectiveness likely depend upon a variety of appropriation factors, some of which include experience, familiarity with the other communicator, etc. In the context of this study, motivation to learn represents just such an appropriation factor, in that the media capabilities may be matched perfectly with the fundamental communication task at hand (i.e., conveyance or convergence), but without a sufficient level of motivation, the communication may not be successful. Following this logic, I argue that a medium that provides multiple symbol sets or high reprocessability can overcome a person's low motivation to learn, thereby resulting in effective communication. Alternatively, a medium that does not provide the required symbol sets or does not allow for reprocessability will inhibit an individual with high motivation to learn in their attempt to gain knowledge from a message. Thus, I hypothesize:

H4b: *Motivation to learn and symbol sets will have an interactive effect on the extent of knowledge internalized by a recipient (especially, their ability to apply that knowledge).*

H4c: *Motivation to learn and reprocessability will have an interactive effect on the extent of knowledge internalized by a recipient (especially, their ability to apply that knowledge).*

Research Methodology

To conduct a preliminary test of the hypotheses, an experimental study using student subjects, and involving the explicit manipulation of symbol sets and reprocessability was conducted. Given that symbol sets and reprocessability had not been tested in prior empirical research, we believed that an experimental study with a common task, same experimental room, and similar background and experiences of the participants, would enable us to not only manipulate these two channel characteristics, but also remove the effect of other extraneous variables, and thereby, observe the sole effects of these two variables on the outcomes of interest. Further, while the use of student subjects has been criticized in prior research, it has also been argued that it is often preferred to use student participants (instead of "practicing managers") in investigating different issues, since managers are "influenced by their work environment and are likely to carry organizational or job-specific perceptions." This makes it difficult to identify and control "organizational influences," and thereby, tends to taint the results (Ruchala, 1999, p. 169).

Sample

The sample of our study consisted of 292 undergraduate students enrolled in an introductory MIS course (required for all business students) at a large US University. Given our focus on understanding the effect of the communication channel, and recipient characteristics on knowledge internalization, we specifically chose an introductory course as our experimental setting, where participants had little a priori domain knowledge. This

enabled us to closely observe the effect of our variables of interest, as opposed to other extraneous variables such as prior exposure to the topic.

Procedure

During the experimental sessions, participants were presented with an on-line tutorial on activity diagramming, and then were asked to complete an activity diagramming related task as in Essay 2. Given our use of pragmatism as our theoretical scaffolding, the use of activity diagrams as our task enabled us to create a closer coupling between the theoretical and empirical aspects of our study.

The study was conducted in multiple sessions, and during the allotted course laboratory sessions. Upon arriving at their assigned course laboratory section, the participants took their seats at a computer terminal. After a short administrative presentation by the lab instructor, the researcher read a verbal instruction script to each section (roughly 30 individuals per section). The participants then reviewed, signed, and dated the informed consent forms. After consenting to participate, the participants were provided a url, and asked to open the url using their respective computers. The web site presented them with an on-line tutorial on activity diagramming.

After completing the review of the tutorial, participants were given the narrative of a business process, and asked to draw an activity diagram to represent it (please see Appendix D). After completing the activity diagram, and turning in their solutions, participants responded to an online survey assessing the strength of the manipulations, their absorptive capacity, motivation to learn, and extent of knowledge internalized. Each experimental session lasted approximately 50-60 minutes. Fourteen days following the

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tutorial presentation and initial activity diagramming task, the study participants returned

to their lab section and completed another diagram on another narrative (see Appendix F)

to test the hypothesis that the passage of time would influence the effect of

reprocessability on knowledge internalized.

Manipulations and Measurement of the Communication Channel Characteristics

A key issue in our empirical study was to select (and develop) an appropriate

operationalization of symbol sets and reprocessability, our two key independent

variables. Given that the MST constructs have yet to undergo empirical testing, and that

our study involved a laboratory experiment, our intent was to start with a basic

operationalization of these two constructs, especially the number of symbol sets (i.e.,

symbol variety) used. In the existing literature, particularly on knowledge management,

symbol sets have been viewed as a form of physical representation (e.g., Amare &

Manning, 2007; Sparrow, 1998). According to this body of literature, "words [or plain

text] are symbols" (Sparrow, 1998, p. 51). For example, Bernsen (1994), in his

categorization of the different types of symbolic representations, suggests that at the

lowest level is language (e.g., written words, text), while pictures such as diagrams are at

higher levels. Similarly, Sparrow's (1998, p. 59) taxonomy categorizes "simple" text as

the first level of the "basic symbolic systems," and diagrams (consisting of boxes and

arrows) at a higher level as "graphical abstract representations." Peirce (1935), a noted

communication theorist, has also argued that basic text should also be viewed as a form

of symbol. Amare and Manning (2007) define "simple" or basic text as those consisting

"minimal visual formatting only: punctuation between major phrases and white space

between words." Amare and Manning (2007), drawing on Solomon (1995), further suggest that emphasized or formatted text represent higher level symbols than basic text, and may be considered as "visual rhetoric" similar to diagrams. To summarize, a review of the literature on representations suggested to us that a basic operationalization of symbol sets (and an appropriate starting point) would be to provide simple text with minimal punctuation, white spaces, etc. Since our objective in this study was to compare the effect of communication channels using a simple symbol set with those consisting of multiple symbol sets on the knowledge internalization effectiveness, and since most taxonomies of representation refer to different types of formatted text, and diagrams or pictures as being higher level symbols, we operationalized symbol sets as follows: 1) text-only with minimal punctuation and font, and 2) text (with added formatting) + diagrams.

Online activity diagramming tutorials manipulating symbol sets and reprocessability were created. Condition 1 consisted of multiple symbol sets and high reprocessability; condition 2 consisted of a single symbol set and high reprocessability; condition 3 consisted of multiple symbol sets and low reprocessability; and condition 4 consisted of a single symbol set and low reprocessability. The single symbol set condition presented the tutorial in a *text-only* format within *minimal punctuation*. The multiple symbol set condition presented the tutorial with the same text as the *text-only* condition, but also included *images* of the different components of activity diagrams, along with *bolded and underlined key words*. See Figure 3.2 and Figure 3.3 for the symbol set manipulations.

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Reprocessability was manipulated either 1) by allowing participants to keep the tutorial window open on the desktop as they worked on the activity diagramming task (i.e., high reprocessability), or 2) by automatically disabling the browser's back button and erasing the url after participants had covered the entire tutorial, such that participants were unable to retrieve the tutorial for future review (low reprocessability) (see Figures 3.4 and 3.5). For the low reprocessability condition, participants were provided a warning that once they "clicked on the next button," they would be directed to the experimental task, and would not be able to review the tutorial anymore. This manipulation was re-used from Essay 2, however, we sought to refine the measurement of reprocessability. We acknowledge that this manipulation is not as controlled as the manipulation of symbol sets, so, in addition to replicating the reprocessability manipulation from Essay 2, we recorded the time at which the participants began the tutorial, and the time that they finished their drawing. A one-way ANOVA was conducted to test whether the resulting elapsed time was the result of the reprocessability manipulation, which would represent a more refined measurement of reprocessability than the binary manipulation. The results of the ANOVA[4] (F = 11.218, p = .001) indicate that the reprocessability manipulation resulted in a longer elapsed time for those in the high reprocessability condition, therefore, the subsequent analyses are carried out with elapsed time as the reprocessability measure.

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[4] To verify that reprocessability was the sole determinant of elapsed time, an ANOVA was carried out with both reprocessability and symbol sets as the IVs, and elapsed time as the DV. There were no significant effects for symbol sets or for the interaction between symbol sets and reprocessability

The program to administer the study was coded in a manner such that as participants logged on to their computers and visited the tutorial url, they would be automatically (and randomly) assigned to one of the four conditions mentioned earlier.

Measurement of the Other Variables

Prior research argues that measuring absorptive capacity is an "econometric challenge," since it is "unobservable" and therefore difficult to "measure directly" (Narasimhan, Rajiv, & Dutta, 2006). As a result, absorptive capacity has been measured using a variety of different methods. For example, at the organizational level, Lane and Lubatkin (1998, p. 468) have measured it as the "breadth of knowledge" captured by the "percentage of research communities associated with a scientific discipline in which a firm was active." Similarly, Leeds (2001, p. 39) measured absorptive capacity as "the number of research communities that a firm's scientists and engineers participate in." Others have measured it by observing the "efficiency with which a firm absorbs know-how from outside" (Narasimhan et al., 2006, p. 515). Szulanski (1996), one of the key proponents of knowledge transfer and its antecedents (including recipient absorptive capacity), and Szulanski, Cappetta, and Jensen (2004) have measured absorptive capacity using a number of different items administered either to the source or the recipient. Given our focus on knowledge internalization in this study, we measured absorptive capacity (of the recipients) using three items adapted from Szulanski et al.'s (1996) scale. We would like to note that prior research examining knowledge transfer at the individual-level (e.g., Ko, Kirsch, & King, 2005) have also drawn on Szulanski's scale for measuring the recipient's absorptive capacity.

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The recipient's motivation to learn has also been measured using a variety of different techniques, though the dominant technique has been to administer an instrument capturing motivation to either the source or the recipient. Szulanski et al. (2004) measured recipient motivation using fourteen different items. Simonin (2004) measured motivation to learn using two different items administered to the recipient. Bures, Amundsen, and Abrami (2002) measured motivation to learn using an instrument capturing four different dimensions of motivation: subjective competence, personal relevance, task attractiveness, and valuing interest. Given the scale's focus on "motivation to learn," as opposed to general recipient motivation, and the fact that it captured a wide range of dimensions related to motivation, in this study, we used Bures et al's (2002) scale for measuring motivation to learn.

As discussed earlier, drawing on the pragmatist epistemology, we view the extent of knowledge internalized as both the knowledge "possessed," and the knowledge "applied." The extent of knowledge possessed as a result of a knowledge transfer has often been measured as a perception of the recipient. Simonin (2004) measured knowledge possessed using three different items that captured the extent to which an organization has learned about (and assimilated) the extent of technology and process know-how from the source. Szulanski et al. (2004) measured this critical construct as the accuracy with which the recipient reproduced the "replica of a template," the template being the new knowledge transferred to the recipient. At the individual-level, Ko et al. (2005) have measured knowledge possessed as the change in the knowledge base of the recipient due to the knowledge transfer process, and have captured it using self-reported items that were administered to the recipient. Other research at the individual-level (e.g.,

Joshi, Sarker, & Sarker, 2007; Sarker et al., 2005) have also measured knowledge transfer using multiple items. Following their guidelines, in this study, knowledge "possessed" was assessed using a perceptual measure, where participants (or recipients) responded to seven questionnaire items regarding the extent to which they have learned activity diagramming (four drawn from Ko et al. (2005) and Joshi et al. (2007), and three newly developed items).

Knowledge "applied" was measured by an objective assessment of the quality of the participants' activity diagrams. Such a technique of measuring recipient learning has been adopted in prior research as well. For example, Gal and Steinbart (1992, p. 135) had measured recipient learning by assessing "subject's performance on a test" after they had used a computer-assisted knowledge transfer program (referred to as CAT). Standard guidelines provided by prior researchers (e.g., Houston, Walker, Hutt, & Reingen, 2001) were utilized to assess the quality of the activity diagram solutions created by the participants. Specifically, two independent raters (neither of whom were associated with the research) rated each activity diagram. In assessing the quality (on a scale of 1 to 7), the raters provided scores on the following: a) completeness of the solution, b) correctness of the solution, and c) the overall quality. For the first 30 participants, the raters performed the coding jointly, to develop a common understanding of the coding procedure. For the rest of the participants, the raters coded the activity diagrams independently. The inter-rater reliability was found to be over .80, which is used as the established benchmark (Houston et al., 2001). The average of the two raters' ratings on each of the three dimensions was used as a measure of knowledge "applied." In other

words, knowledge applied was measured as a construct composed of three underlying

sub-dimensions: completeness, correctness, and overall quality of the solution.

Please see Appendix E for the specific items of our measurement instrument.

Analysis Technique

PLS-Graph Version 3.00 was used to analyze the data. PLS has been shown to be

a superior technique when it comes to analyzing interaction terms, and when the model

has second-order factors (e.g., Chin et al., 2003; Lohmuller, 1989), and thus was

appropriate for the current study which has a second-order factor (i.e., motivation to

learn) and involves several moderating relationships (therefore, requiring the inclusion of

interaction terms). Following the guidelines of prior researchers (e.g., Brown &

Venkatesh, 2005; Gefen & Straub, 2005; Bhattacharya & Premkumar, 2004; Chin,

Marcolin, & Newsted, 2003; Hulland, 1999), in the first phase, the validity and reliability

of the measurement model was assessed, followed by an assessment of the hypothesized

relationships.

For validating the scales we conducted a confirmatory factor analysis, which has

been shown to be a preferred technique when the model has been developed by drawing

on strong theoretical bases, and when using instruments that have been validated in prior

studies. Chin (1998) suggests that when reporting results from an empirical analysis,

researchers should provide the following information: item means, item loadings,

structural paths and estimates, and r-square. We have followed these guidelines in

reporting our results.

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Prior research suggests that convergent validity of items can be established by satisfying the following three criteria: First, each item should load significantly on their respective constructs. While many researchers suggest that items should have a loading of .70 or above, others suggest that it is "often common to find that at least several measurement items in an estimated model" have loadings below the ".70 threshold, particularly when new items or newly developed scales are employed" (Hulland, 1999; p. 198). Researchers further suggest that items with loadings below .50 should be dropped. Second, the composite reliabilities should be greater than .70, and third, the average variance extracted (AVE) for each construct should be greater than .50). In this study, results indicated the following: 1) all items loaded significantly on their respective constructs, and most items had a loading above .70[5] (see Table 4.1); 2) the composite reliabilities of each of the items were above .70 (see Table 4.2); and finally, 3) the Average Variance Extracted (AVEs) of all the constructs were over the threshold value of .50 (see Table 2 which shows the square roots of the AVEs on the main diagonal). This established the convergent validity of the instruments.

Gefen and Straub (2005, p. 93) suggest that discriminant validity can be established by ensuring that the square root of the AVE of a construct exceed all correlations between that and any other construct within the study. In our study, the instrument validation results suggest that the square root of the AVE of each of the constructs in the study exceeded all correlations between that factor and other constructs within the study with one exception (see Table 4.2, which reports the square root of the

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[5] As suggested by prior research (e.g. Hulland, 1999), items that had a loading of less than .50 were dropped, and the data was reanalyzed. As a result of this cut-off, one item measuring motivation to learn (valuing subject/interest) was dropped after the first-round of analysis.

AVEs of the constructs on the main diagonal, and the correlations between that construct and other constructs on the off-diagonal cells).The exception in this study is with the square root of AVE for absorptive capacity, which is lower than the correlation between absorptive capacity and the self-report measure of the extent of knowledge transferred. However, further examination of the table suggested that the AVE for the extent of knowledge transferred is higher than the correlation between the two constructs, which suggests that discriminant validity of the two constructs may not be a concern. In order to further verify the discriminant validity of these two measures, we followed Gefen and Straub (2005, p. 93), who suggest that a more *sophisticated test* of discriminant validity involves the examination of the correlation between the latent variable scores with the measurement items, and ensuring that the measurement items load higher on their "assigned factor," than on any other factors. Consequently, we calculated the latent variable scores for each variable, and then observed the correlations of these scores with each of the items. Table 4.3 highlights that each of the items in our study has a higher correlation with their respective factors than with the other factors. While the items measuring absorptive capacity have a relatively higher correlation with the extent of knowledge transferred factor, they are still *lower* than their loadings on their respective factor (i.e., absorptive capacity), thereby confirming that absorptive capacity and extent of knowledge transferred are indeed two different constructs, and have adequate discriminant validity.

Table 4.1: Item Means, Standard Deviations, and Loadings

Construct	Item	Mean	Standard Deviation	Loading	Mean Loading
Subjective	KTS1	4.16	1.45	0.85	0.85
	KTS2	3.86	1.51	0.89	0.89
	KTS3	4.04	1.66	0.52	0.53
	KTS4	3.76	1.72	0.68	0.68
	KTS5	4.18	1.55	0.90	0.90
	KTS6	4.01	1.50	0.88	0.88
	KTS7	4.12	1.58	0.91	0.91
Objective Time 1	KTOT11	7.03	2.45	0.92	0.92
	KTOT12	5.18	2.17	0.95	0.95
	KTOT13	5.84	2.21	0.99	0.99
Objective Time 2	KTOT21	7.95	2.71	0.97	0.97
	KTOT22	5.95	2.32	0.95	0.95
	KTOT23	6.75	2.46	0.99	0.99
Absorptive Capacity	AC1	4.16	1.60	0.79	0.79
	AC2	2.59	1.76	0.51	0.50
	AC3	4.26	1.57	0.86	0.86
	AC4	4.41	1.61	0.85	0.84
Motivation to Learn – Personal Relevance	MTLPR1	4.33	1.56	0.94	0.94
	MTLPR2	4.23	1.62	0.91	0.91
	MTLPR3	3.38	1.76	0.75	0.75
Motivation to Learn – Subjective Competence	MTLSC1	3.38	1.46	0.86	0.87
	MTLSC2	3.92	1.54	0.89	0.89
	MTLSC3	3.73	1.44	0.92	0.92
	MTLSC4	4.19	1.59	0.76	0.76
Motivation to Learn – Task Attractiveness	MTLTA1	3.62	1.73	0.82	0.82
	MTLTA2	3.00	1.56	0.93	0.93
	MTLTA3	3.06	1.53	0.89	0.89
Motivation to Learn – Valuing Subject/Interest	MTLVS1	4.62	1.69	0.72	0.73
	MTLVS2	4.05	1.59	0.85	0.85
	MTLVS3	4.92	1.47	0.72	0.72
	MTLVS4	4.86	1.52	0.79	0.79

Table 4.2: Composite reliabilities, Correlations between the Constructs, and AVEs of the Constructs

Construct	Composite Reliability	1	2	3	4	5	6	7	8	9	10
1 KT (Subjective)	.931	**.817**									
2 KT Time 1 (Objective)	.968	.340	**.953**								
3 KT Time 2 (Objective)	.978	.278	.555	**.969**							
4 Absorptive Capacity	.844	.631	.321	.268	**.764**						
5 Motivation to Learn (Subjective Competence)	.918	.491	.300	.230	.590	**.860**					
6 Motivation to Learn (Personal Relevance)	.903	.259	.145	.084	.174	.228	**.871**				
7 Motivation to Learn (Task Attractiveness)	.911	.426	.200	.126	.384	.337	.571	**.880**			
8 Motivation to Learn (Valuing Subject/Interest)	.855	.014	.019	.029	.040	.118	.342	.243	**.772**		
9 Symbol Sets	1.00	.392	.376	.207	.392	.277	.135	.223	-.020	**1.00**	
10 Reprocessability	1.00	.031	.071	.031	-.016	.019	-.054	-.052	.087	-.141	**1.00**

Note: Square roots of AVE are presented in bold on the diagonal, with off diagonals highlighting the correlations between the constructs.

Table 4.3: Correlations Between the Items and the Constructs

	Symbol Sets	Reprocess-ability	Absorptive Capacity	Subjective	MTLpers	MTLsub	MTLtask	MTLval	Objective T1	Objective T2
SS	**1.00**	-0.14	0.39	0.39	0.14	0.28	0.22	-0.02	0.38	0.21
RP	-0.14	**1.00**	-0.02	0.03	-0.05	0.02	-0.05	0.09	0.07	0.03
ac1	0.37	-0.02	**0.78**	0.64	0.23	0.36	0.38	0.03	0.24	0.16
ac2	0.21	-0.09	**0.51**	0.23	0.08	0.21	0.29	-0.11	0.12	0.14
ac3	0.30	0.00	**0.86**	0.45	0.06	0.52	0.24	0.07	0.29	0.24
ac4	0.30	0.02	**0.85**	0.51	0.13	0.63	0.28	0.07	0.30	0.28
ekt1	0.31	0.03	0.55	**0.85**	0.23	0.41	0.33	0.01	0.25	0.25
ekt2	0.37	0.04	0.52	**0.89**	0.24	0.35	0.34	-0.05	0.29	0.22
ekt3r	0.24	0.02	0.23	**0.52**	0.27	0.22	0.22	0.04	0.20	0.15
ekt4	0.36	-0.06	0.59	**0.68**	0.15	0.56	0.35	0.04	0.27	0.24
ekt5	0.33	0.06	0.57	**0.90**	0.21	0.42	0.41	0.02	0.30	0.23
ekt6	0.28	0.08	0.50	**0.88**	0.23	0.35	0.38	0.01	0.30	0.20
ekt7	0.33	0.02	0.52	**0.91**	0.21	0.42	0.36	0.03	0.32	0.27
mtlpr1r	0.14	-0.06	0.15	0.22	**0.94**	0.22	0.49	0.33	0.12	0.08
mtlpr2r	0.14	-0.03	0.11	0.20	**0.91**	0.21	0.45	0.36	0.13	0.08
mtlpr3r	0.06	-0.05	0.21	0.25	**0.75**	0.16	0.57	0.19	0.13	0.06
mtlsc1	0.28	0.00	0.56	0.47	0.20	**0.86**	0.40	0.04	0.23	0.20
mtlsc2	0.22	0.00	0.53	0.38	0.19	**0.89**	0.29	0.17	0.26	0.24
mtlsc3	0.26	0.07	0.57	0.49	0.14	**0.92**	0.33	0.08	0.27	0.22
mtlsc4r	0.19	0.00	0.35	0.35	0.26	**0.76**	0.26	0.11	0.28	0.12
mtlta1r	0.17	0.00	0.29	0.34	0.61	0.31	**0.82**	0.28	0.17	0.09
mtlta2	0.21	-0.07	0.36	0.40	0.45	0.35	**0.93**	0.21	0.18	0.13
mtlta3	0.20	-0.08	0.36	0.39	0.43	0.33	**0.89**	0.14	0.17	0.11
mtlvs1r	-0.01	0.03	0.00	0.01	0.38	0.02	0.14	**0.72**	0.04	0.04
mtlvs2	0.01	0.11	0.06	0.02	0.22	0.16	0.26	**0.85**	-0.02	0.00
mtlvs3	-0.08	0.06	0.05	0.07	0.16	0.06	0.14	**0.72**	0.03	0.04
mtlvs4r	0.00	0.06	0.01	-0.05	0.29	0.11	0.18	**0.79**	0.03	0.02
t1comp	0.30	-0.03	0.28	0.29	0.11	0.25	0.17	0.01	**0.92**	0.52

t1corr	0.39	0.13	0.32	0.33	0.15	0.30	0.20	0.03	**0.95**	0.52
t1qual	0.37	0.08	0.32	0.34	0.14	0.31	0.20	0.01	**0.99**	0.55
t2comp	0.22	0.03	0.25	0.27	0.07	0.20	0.13	0.03	0.51	**0.96**
t2corr	0.14	0.04	0.26	0.24	0.08	0.23	0.11	0.03	0.51	**0.96**
t2qual	0.23	0.03	0.28	0.29	0.09	0.24	0.13	0.02	0.58	**0.99**

In the following phase of the analysis, the significance and strength of the hypothesized relationships were examined. To test the moderating effects, interaction terms were created following the product-indicator approach suggested by Chin et al. (2003). Chin et al. (2003) suggests that each indicator of the moderator variable should be multiplied with each and every indicator of the predictor variable to create product indicators. These product indicators would be reflective of the latent interaction variable. Chin et al. (2003, p. 2003) cautions researchers that "one important step in undertaking the PLS product-indicator approach is to decide whether indicators must be standardized or centered." Miles and Shevlin (2001) suggests that when the interaction involves two continuous variables, the data (of both the variables) should be standardized, while in an interaction involving a continuous and a categorical variable, the continuous variable should be centered. Finally, for an interaction involving two categorical variables, a simple product term needs to be calculated. Based on the above suggestions, appropriate product indicators (after standardization or centering wherever relevant) were created and entered into the path analysis. Results of the path analysis, including the path coefficients, path significances, and the variance explained for each endogenous variable are shown in Figure 6.

The second-order factor of motivation to learn was modeled using a "molecular approach." This approach suggests that "an overall latent construct exists and is indicated by the first order constructs" (Chin & Gopal, 1995, p. 49-50). In this study specifically, the molecular approach suggests that our second order factor (i.e., motivation to learn) is indicated by the relevant first order constructs (valuing interest, etc.). To test our hypotheses, we created a hierarchical component model using repeated manifest variables

(to address the issue of second-order factors), following the guidelines of Chin et al. (2003) and Lohmoller (1989). Specifically, the manifest variables for the four dimensions of motivation to learn were included twice: once for each of the four dimensions, and once for the second order factor. All of the path coefficients from Motivation to Learn to its four dimensions were high, with coefficients ranging from .50 to .82. This suggested that "motivation to learn" was indeed indicated by the underlying first order factors.

To assess the strength of the manipulations, we administered three items to the participants, one for each manipulation. Results indicated that there was a high and significant correlation between the participants' assessments of the manipulations and the actual manipulations (symbol sets: $r = .383$, $p < .01$, reprocessability: $r = .330$, $p < .01$).

Results provided strong support for many of the hypothesized relationships in the model. Symbol sets had a significant effect on both measures of knowledge internalization (knowing and applying) at Time 1 (see Figure 4.1). On the other hand, reprocessability only had an effect on the objective measure of knowledge internalization. Participants' perceptions about their absorptive capacity significantly affected their perceptions of knowledge "possessed," but failed to have an effect on their application of that knowledge. Further, as hypothesized, motivation to learn had a significant effect on the knowledge possessed measure, but not the knowledge applied measure. Overall, the variance explained by symbol sets, reprocessability, absorptive capacity, and motivation to learn on the two measures of knowledge internalization were 45.8% and 32.2% respectively (See Figure 4.2). Finally, the predicted moderating effects of absorptive capacity on the relationships between symbol sets and reprocessability, and motivation to learn and symbol sets and reprocessability, and knowledge application was not supported.

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At time 2, only the objective measure of knowledge internalization was collected and the results of the time 2 data are presented in Figure 4.2. As at Time 1, the relationships between the media capabilities (symbol sets and reprocessability) and the knowledge applied DV are significant. However, the strength of the relationships are weaker at time 2 than time 1, which is contrary to the hypothesis that reprocessability will result in a stronger effect at time 2, but consistent with the hypothesis for symbol sets. Furthermore, less variance is explained in knowledge applied at time 2 than at time 1 providing further support for the hypothesis that over time, the beneficial effects of the media capabilities will wane.

Figure 4.1: Model with Path Coefficients and Variance Explained in the DVs at Time 1
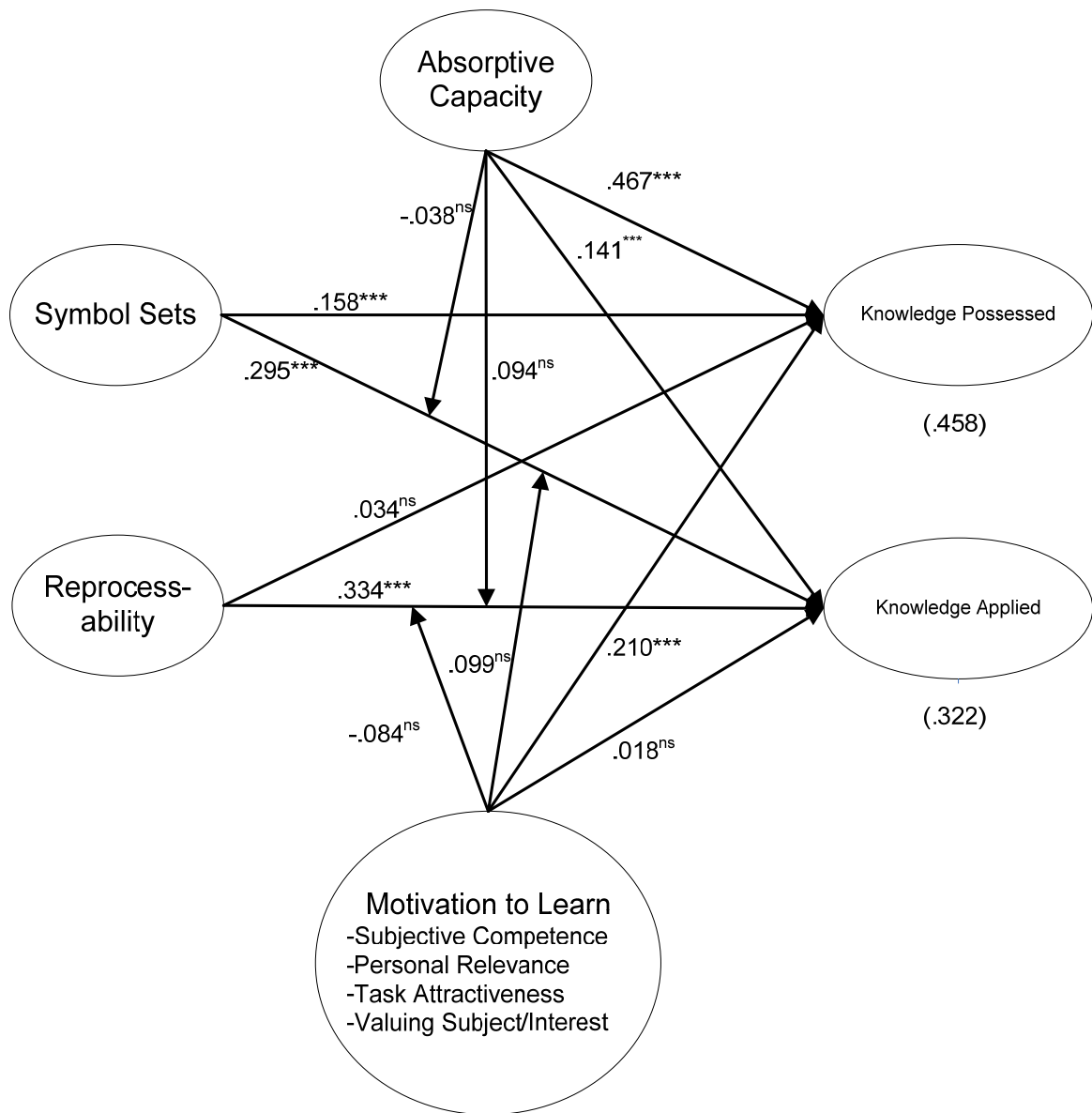
Figure 4.2: Model with Path Coefficients and Variance Explained in the DVs at Time 2
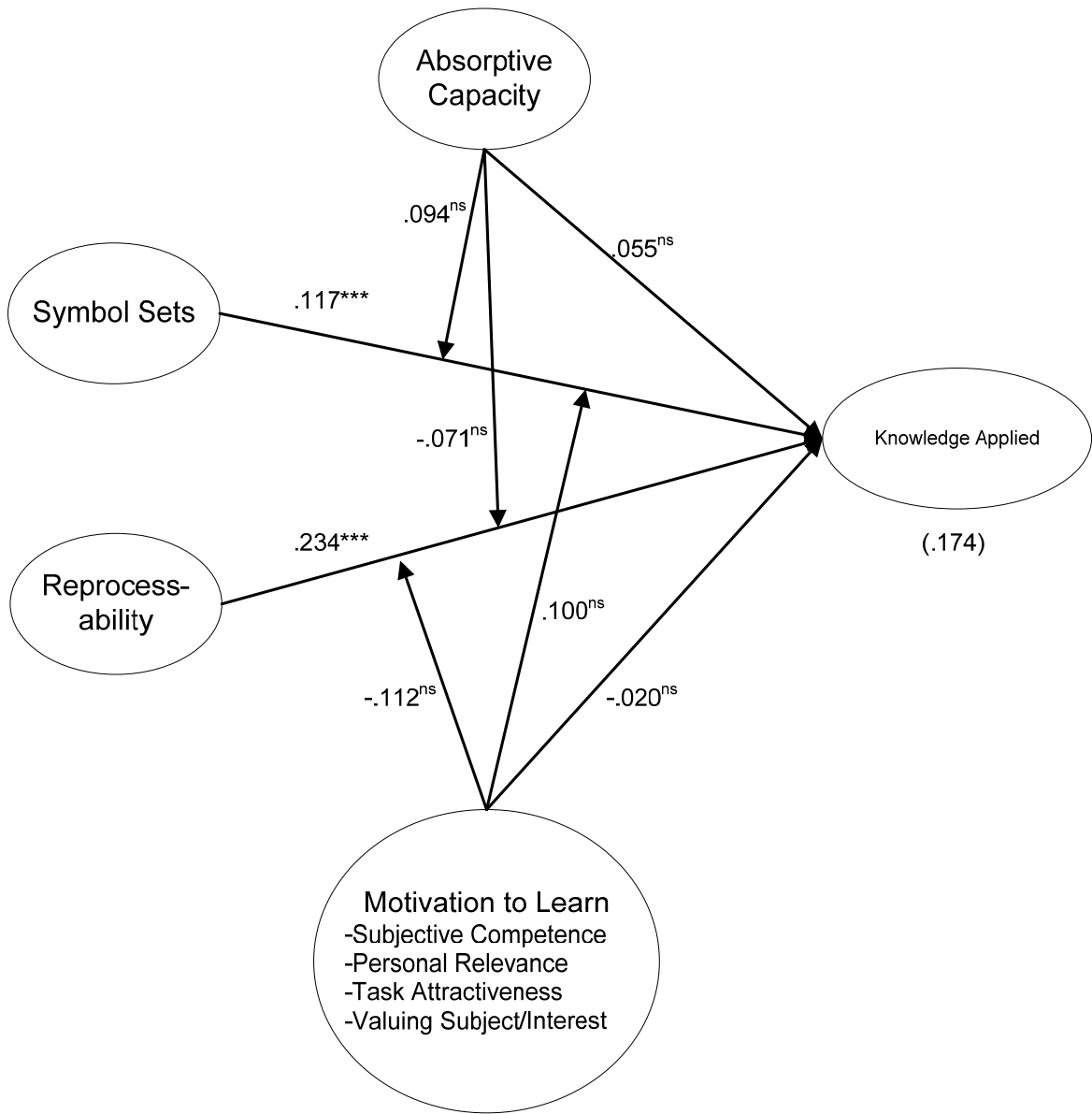
Discussion

The results of the empirical study suggest that symbol sets and motivation to learn

each have a significant effect on both dimensions of knowledge internalization (i.e.,

knowledge possessed and knowledge applied). Further, the more rigorous measurement of reprocessability led to significant effects on knowledge applied at both time 1 and time 2.

Contrary to expectation, absorptive capacity did not have a significant effect on the application of new knowledge. Given that absorptive capacity refers to not only the ability to value and assimilate new knowledge, but also the ability to "apply it to achieve.. objectives," (Lane & Lubatkin, 1998, p. 464), this result was unexpected. It could be that even though participants had the ability to apply the knowledge, they failed to do so owing to their lack of motivation and objectives. This suggests that there could potentially be an interactive effect of absorptive capacity and motivation to apply relevant knowledge, and this relationship needs to be examined in future research. Furthermore, the hypothesized interactions between the media capabilities and recipient characteristics did not receive support from the data. With the second-order factor of motivation to learn, and the added number of indicators required to utilize the product-indicator approach, a much larger sample size may be required, even with PLS, to have confidence in the results of the interactions hypothesized in this research.

Contributions

Overall, we believe that the study makes some significant contributions to both the literature on user-computer interaction and knowledge transfer. Specifically, the study informs prior and limited research on the role of channel and recipient characteristics on knowledge transfer in the following ways:

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It draws on more contemporary literature on channel characteristics (that rejects the idea that media is "monolithic" in terms of its richness), and illustrates the effect of media characteristics (that encompass both its objective characteristics and its information processing capabilities) on knowledge internalization, which we believe, has not been examined before.

Prior literature has examined knowledge internalization by focusing on the extent to which an individual "knows" (or possesses knowledge about) a particular material. This study, adopting the pragmatist philosophy, takes a step forward, and focuses on "knowledge application" in addition to knowledge "possession." The results suggest that knowledge application is much different from knowledge possession, and highlights that for complete knowledge internalization, it is not only important for an individual possesses the relevant knowledge, but also to seamlessly apply it in other contexts. This finding, we believe has important theoretical and practical ramifications.

Related to the above issue, and remaining true to the pragmatist philosophy of "pluralism," our study also sought to examine the role of the independent variables on two different dependent variables, or components of knowledge internalization. This we believe is an important contribution, since much of the prior studies on knowledge transfer studies has typically focused on one specific dependent variable only (i.e., knowledge transferred or gained).

Further, the study's focus on the critical role of the dimensions of the IT interface (i.e., symbol sets and reprocessability) on the knowledge recipient's learning makes an important contribution to the rich body of HCI literature, where the impact of IT on individual learning has received very little attention (Zhang & Li, 2005).

We also believe that this study offers a foundation for future research, especially in the domain of communication channel characteristics. While the theoretical concepts of MST have been acknowledged within the IS discipline, there are no known empirical studies that have specifically manipulated the characteristics proposed by MST, and examined their effects. We believe that this study provides an illustration of how the characteristics proposed by MST (especially, symbol variety and reprocessability) may be manipulated, and therefore empirically tested.

Finally, existing literature seems to be divided regarding the role of symbol variety on communication outcomes, with some scholars arguing for a positive effect of the number of symbol sets used on communication outcomes (e.g., Walther et al., 2001), with others arguing that too many symbols tend to cause distractions for the recipient, and therefore lead to lower effectiveness (e.g., Williams, 1977). Still others suggest that the role of symbol sets is contextual, depending on the nature of the task being performed. Based on a <u>controlled</u>, <u>empirical</u> analysis, our study indicates, in line with the work of Ma and Agarwal (2007), that in the context of knowledge internalization, multiple symbol sets can work positively, thereby contributing toward a resolution to this debate.

Practical Implications

We believe that our study results in some important practical contributions, especially in the context of knowledge acquisition, learning, and online or e-training in organizations. Both researchers and practitioners suggest that one of the most "productive and readily accessible" means of acquiring new knowledge in organizations is through

interpersonal communication channels such as face to face communication with colleagues (Dewhirst, 1971). However, recent literature and anecdotes from practice seem to indicate that while such channels might be easier to access, individuals often avoid it due to the "psychological cost," and fear of "making a partial admission of the intellectual superiority of that colleague" (Dewhirst, 1971, p. 307). Consequently, there has been an increasing trend in the maintenance of electronic knowledge systems, albeit with some reservations, with the objective of fostering knowledge sharing and learning by organizational members. Our study indicates that in the presence of appropriate recipient characteristics and channel features (symbol sets and reprocessability), organizations may be able to enable the absorption of new knowledge and its application by organizational members, without having them to incur psychological costs of seeking more knowledgeable colleagues.

The results of our study also have important implications for professional communicators. In today's digital age, professionals often need to communicate using the electronic media. Further, different knowledge sharing/acquisition forums (e.g., communities of practice) exist over the electronic media (i.e., the Internet). While current technologies enable the use of multiple symbols, it must be acknowledged that much of this knowledge acquisition/internalization still takes place through the use of text or written chat sessions (e.g., Lesser and Fontaine 2004). While our results show that low symbol variety has a negative effect on knowledge internalization, we believe that it should not be viewed as disheartening for professional communicators or knowledge recipients. The results of our interaction analysis suggest that high absorptive capacity of the recipient can overcome the challenges posed by a media with low symbol sets, and

still result in high knowledge internalization. It is thus important for professional communicators, who often find themselves having to communicate (and facilitate the knowledge internalization of other recipients) using a medium with low symbol variety, to positively nurture the absorptive capacity of their recipients, either by exposing them with supplementary material on the topic, or even by offering continuous exposure to the necessary material (such that recipients are able to reprocess it several times), in an effort to enable them to grasp, internalize, and put into practice new knowledge efficiently and effectively.

A final practical implication that our study provides, for organizational members in general and professional communicators in particular, is that there is a difference between what new knowledge one possesses, and whether he/she is able to apply that new knowledge in a relevant context; in the words of Cook and Brown (2002, p. 78) whether the individual is able to transform that knowledge into "concrete ... human action." Often times, an individual might have been able to absorb a level of knowledge, but may fail to apply (or use) it effectively when the need arises. Since for organizational members, action and application is of utmost importance, and given our results, we believe that professional communicators (who are agents for disseminating new knowledge such that certain organizational outcomes can be achieved) should not only ensure that their knowledge has been successfully absorbed by the recipient, but also make sure that the recipients are able to apply it effectively. In other words, it is not advisable for them to take for granted the success in knowledge transfer until they are confident that the recipients of their communication (i.e. knowledge sharing) been able to successfully apply this knowledge in other contexts. Similarly, recipients should

understand, that simply possessing knowledge is not enough, and they should continually strive to ensure that they are able to apply that new knowledge in other contexts. It is only through this *application* that knowledge internalization would be complete.

While we are excited about the contributions, we must acknowledge that like all other studies, this investigation also has some limitations, which we discuss below.

Limitations

One of the potential limitations arises from the fact that respondents provided assessments of the predictor (e.g., absorptive capacity and motivation to learn) and the criterion variable (i.e., knowledge possessed) at the same time, and after completing the tutorial and the experimental task. While this is not an uncommon practice, recently, some researchers have raised common method variance (CMV) concerns regarding such studies (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). While our study could have potentially been affected by CMV, we believe that it is not a concern here, due to the two following reasons: 1) the use of established instruments (as in this study) reduces the threats associated with CMV (Podsakoff et al., 2003); and 2) We conducted the widely-known Harmon's single-factor test to check for CMV (e.g., Bhatt & Grover, 2005; Podsakoff et al., 2003), which indicated that CMV was not a major problem. Further, our confirmatory factor analysis, viewed as a "sophisticated test" of CMV (Podsakoff et al., 2003, p. 889), also revealed that the items had higher loadings on their respective factors (as opposed to other factors).

Another potential limitation of the study could be the use of student subjects in an introductory MIS course, the majority of whom had little (or no prior) knowledge of

business process modeling or activity diagrams. While this lack of prior knowledge enabled us to enforce strict experimental controls, it could have also hindered their ability to absorb the new knowledge and apply it independently to accomplish a task. Given that existing research has often emphasized the importance of prior related knowledge on recipient's ability to apply that knowledge, future research using more senior students or organizational members could help enhance confidence in the validity of the results from this study.

Finally, in this study, in the interest of maintaining strict experimental controls, we adopted a fairly basic operationalization of symbols sets (i.e., simple text with minimal punctuation, and text (with added formatting) + diagrams). This simple operationalization may have reduced the practical relevance of the study. However, prior literature has indicated (e.g., Lee 1994), that simple text can also be evocative and rich. Lee (1994, p. 154), specifically states that through "distantiation, autonomization, social construction," text can convey a "world of meaning," which is much more than the simple "dictionary definition of the words in which it was written." Others have also argued that the use of text only, necessarily does not lead to inferior results (e.g., Sparrow 1995). Finally, much of organizational knowledge acquisition, and communication still today occurs through the use of written text (memos or email). For example, Lesser and Fontaine (2004) suggests that "online chats with experts" are very commonly offered by technology organizations (e.g., SAP) today, and are regularly used by customers for knowledge acquisition about (or to learn) a new tool. Since such "synchronous chats" often do not provide anything but simple textual symbols, we believe that our basic

operationalization of symbol sets simulates such situations, and thus, does not necessarily lack in relevance.

Future Research

We believe that our study points to several avenues for future research. The results of this essay, while somewhat consistent with the results of Essay 2, bear some significant differences from the Essay 2 results. With respect to the effect of reprocessability, this research has identified an alternative measurement technique to assess the level of reprocessability in such an experimental context. There are likely other factors that influenced the elapsed time from beginning the tutorial to ending the drawing, such as reading speed and comprehension, however, we believe this measure to be a more controlled assessment of reprocessability than the crude dichotomization resulting from the manipulation. Further research should further refine the measurement issues of reprocessability.

Further, in this study, we examined the role of motivation as a moderator of the relationships between symbol sets and reprocessability and knowledge internalization. However, those relationships were found to be non-significant. Considering the multidimensional nature of the motivation to learn construct, future research should examine the sub-dimensions of motivation to learn to explore the possibility of such an interaction at a more refined level.

Finally, in this study we introduced some basic manipulations of symbol sets (i.e., text only, and text (with added formatting) + images). Future research could introduce

additional symbol sets (e.g., voice in addition to text and images vs. only text and images), and compare the effect of those complex sets of symbols on knowledge internalization. Given that prior literature suggests that the use of multiple and complex symbols can cause delays in decoding, and thereby lead to confusion and distractions on behalf of the user (e.g., Williams, 1977), it may be interesting to examine whether the addition of complex symbols (such as the ones mentioned above) leads to higher or lower knowledge internalization. In any case, there is much to be learned about knowledge internalization, particularly as it pertains to individuals, and we hope this study contributes significantly in this direction.

CHAPER FIVE

Summary and Future Research

This chapter summarizes the research from the three essays and discusses future directions for continued research.

Summary

This dissertation represents an initial empirical test of several tenets of Media Synchronicity theory (MST). The first essay (chapter 2) addresses an ongoing concern in research on media effects. A variety of researchers (e.g., Carlson & Zmud, 1999; Ngwenyama & Lee, 2007) have criticized the concept of media "richness" for not fully capturing the social nature of communication. These criticisms are well founded and their research has brought attention to the nature of the relationship between the communicators, between the communicators and the medium, and between the communicators and the task at hand, as important aspects that tend to get lost in research that evaluates media effects.

MST not only identifies various media capabilities, but also incorporates the social nature of communication by highlighting the concepts of conveyance and convergence, and by providing illumination on the appropriation factors that may influence how the communicators interact with the medium they've chosen. However, just because an individual (or dyad, or group) may not appropriate a medium to its full capability, that does not invalidate that a particular medium possesses such objective qualities. Furthermore, individuals may not fully understand the capabilities that a

medium may provide. Therefore, essay 1 serves to provide a measurement instrument with which to measure an individual's preconceived perceptions of the capabilities of a medium.

Essay 2 (chapter 3) consists of an experimental study that was used to provide supportive evidence for two propositions of MST, and to extend the range of "appropriation factors" by examining absorptive capacity and motivation, along with symbol sets and reprocessability, on the communication recipient's ability to perform a task based on a message. The results of the study suggest that multiple symbol sets influenced participants' ability to perform the diagramming task positively, while reprocessability had marginal effects. Absorptive capacity and motivation to learn influenced participants' perception of the extent of knowledge they gained after doing the tutorial. And finally, symbol sets interacted with absorptive capacity on the objective measure of performance indicating that individuals with low absorptive capacity could still perform well with multiple symbol sets, and that those with high absorptive capacity could overcome a medium with a single symbol set.

Essay 3 (chapter 4) presents a replication of the study performed in essay 2, but with changes that were made based on insights gained from the first study. The marginal results reported for reprocessability in the first study may have been the result of lack of control on the reprocessability manipulation. Furthermore, the lack of an effect of reprocessability may have been an issue related to the passage of time between the tutorial and the diagramming task. In essay 3, I have included a more rigorous assessment of reprocessability, and incorporated a time delay to assess participants' recall and retention of the message contained in the tutorial. Results suggest that elapsed time

from opening the tutorial to finishing the drawing is a more rigorous assessment of reprocessability, and an effect for reprocessability on both dependent variables emerged in this study. Additionally, while the media effects weren't exactly as expected in the time 2 data, the longitudinal results suggest a steady decay of knowledge from the tutorial over a 14 day period.

Future Research

As research focusing on MST continues, rigorous, tightly controlled experiments are still required to evaluate other elements of the theory that were not touched upon in this dissertation. Specifically, the underlying communication task, in MST parlance, in essays 2 and 3 was a conveyance task. This study could be replicated using a convergence task where communicators must come to a shared understanding with respect to some message. This could be accomplished with a hidden profile task where we can measure how well the communicators were able to come to a shared understanding. Furthermore, the studies in this dissertation only consider symbol sets and reprocessability, future research could use the experimental strategy used in these studies to perform similar studies on transmission velocity, rehearsability, and parallelism. Finally, this research was carried out from the recipient's perspective. Future research should examine these same issue from the sender's perspective and the experimental procedures should provide a framework for doing so.

In addition to continued rigorous and tightly controlled research to provide initial empirical support for MST, research in field settings could attempt to replicate the results obtained in more controlled environments. In such field settings, the instruments

developed in essay 1 can be used to assess how individuals, and even groups of

individuals, perceive the capabilities of a medium, and how those perceptions are either

the same, or different from how they actually appropriated a particular medium.

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APPENDIX A

Instructions and Initial Item Bank

Thank you for your participation in this research. This survey is designed to collect information about your perceptions of a given communication medium. Communication media (i.e. e-mail, instant messenger, telephone, face to face, video conference, written letters, etc.) possess certain characteristics that may make one medium preferable to another depending on the message that needs to be conveyed, or the intentions of the communicators. The five sets of statements below will ask you about your perceptions of these characteristics with respect to different media.

This survey is lengthy, 100 statements, and should take between 30 and 40 minutes. Please set aside an appropriate time to complete the survey. You may get up during the survey for a short break to stretch your legs, get a drink, etc., however, do not close this window, as your contribution will be lost. You must keep this window open until you have finished the entire survey. On the final page of the survey, rather than a Next>> link, there will be a Done>> link. You must click the Done>> link to ensure proper recording of your responses.

This data collection has been approved by the WSU Institutional Review Board. Your responses will remain anonymous. If you are receiving class credit for participating, you will need to provide your WSU ID# and Metro login ID to receive proper credit. However, this information will be kept separate from your responses to the survey items. Furthermore, if you do not need the credit for a class, you may elect to omit your WSU ID and Metro ID. You may also choose not to participate.

As with many surveys, the statements that you will respond to will seem repetitive, even identical. While this may seem to be the case, it is important that you respond to each item individually, not based on how you responded to a previous statement. Please answer each item as honestly as you can. Again, thank you for your participation.

Transmission Velocity

In this section, evaluate the communication medium on its ability to provide quick feedback. For example, when you are speaking to another person face to face, feedback is almost instantaneous. However, for a letter sent by snail mail, feedback would be very slow. Please respond to the following statements using the following scale.

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neutral				Strongly Agree

1. [The medium] allows me to provide immediate feedback to the person I'm communicating with.
2. I can receive feedback immediately when I use [the medium].

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3. It takes a long time to receive feedback when I use [the medium].*
4. [The medium] supports rapid two-directional communication.
5. Rapid communication in both directions is possible with [the medium].
6. It takes a long time to give feedback when I use [the medium].*
7. I expect to give feedback immediately when I use [the medium].
8. [The medium] supports rapid feedback.
9. I can give instantaneous feedback when I use [the medium].
10. [The medium] allows me to receive immediate feedback from the person I'm communicating with.
11. I can get instantaneous feedback when I use [the medium].
12. I expect to get feedback immediately when I use [the medium].
13. [The medium] does not support rapid feedback.*
14. [The medium] does not support rapid two-directional communication.*
15. Rapid communication in both directions is not possible with [the medium].*
16. I can give feedback immediately when I use [the medium].
17. Quick feedback is possible with [the medium].
18. Quick feedback is not possible with [the medium].*
19. [The medium] is slow to provide feedback from the person I'm communicating with.*
20. [The medium] is fast to provide feedback from the person I'm communicating with.

Symbol Sets

In this section, evaluate the communication medium on its ability to provide information in multiple ways. For example, in a face to face communication context, body language and other physical cues provide additional ways that information can be communicated besides just the content of the verbal communication. On the other hand, in a written letter, one may be limited in the number of ways information can be communicated by their literary and/or artistic ability. Please respond to the following statements using the following scale.

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neutral				Strongly Agree

1. [The medium] provides a number of ways to communicate information.
2. I can communicate information in many ways using [the medium].
3. I am limited in the number of ways I can communicate information by [the medium].*
4. [The medium] can communicate information in a lot of different ways.
5. [The medium] limits the number of ways I can communicate information.*

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* Reverse Scored Item

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6. The number of ways information can be communicated using [the medium] is high.
7. The number of ways information can be communicated using [the medium] is low.[*]
8. [The medium] allows me to communicate information in many ways.
9. Information can be transmitted several ways with [the medium].
10. [The medium] allows communication of information in a number of different ways.
11. Information can be communicated in many ways with [the medium].
12. [The medium] is good at providing different ways to communicate information.
13. [The medium] is not good at providing different ways to communicate information.*
14. [The medium] allows only a few ways to communicate information.*
15. Communication of information in many ways is possible using [the medium].
16. Communication of information in many ways is not possible using [the medium].
17. It is possible to communicate information in a number of ways using [the medium].
18. It is not possible to communicate information in many ways using [the medium].
19. It is possible to communicate information in many ways using [the medium].
20. I am able to communicate information in several ways using [the medium].

Parallelism

In this section, evaluate the communication medium on its ability to enable simultaneous conversations. For example, in a face to face communication context, it can be difficult to carry on conversations with more than one person at the same time. On the other hand, when writing letters, it is possible to carry on several conversations at once with several different people. Please respond to the following statements using the following scale.

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neutral				Strongly Agree

1. I can have many conversations at the same time using [the medium].
2. [The medium] allows few conversations to exist at the same time.*
3. It is possible to have multiple conversations at the same time using [the medium].
4. [The medium] cannot carry many simultaneous conversations.*
5. It is not possible to have multiple conversations at the same time using [the medium].*
6. [The medium] allows multiple conversations to exist at the same time.
7. When I use [the medium], I can have multiple conversations at the same time.
8. [The medium] can carry many simultaneous conversations.
9. Several conversations can exist at the same time while using [the medium].
10. Many simultaneous conversations can exist while using [the medium].
11. Not many simultaneous conversations are possible using [the medium].*

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[*] Reverse Scored Item

12. It is difficult to have multiple conversations at the same time while using [the medium].*
13. [The medium] supports multiple simultaneous conversations.
14. It is easy to have multiple conversations at the same time while using [the medium].
15. [The medium] allows me to participate in several conversations at the same time.
16. [The medium] allows several conversations to occur at the same time.
17. I cannot participate in multiple conversations at the same time using [the medium].
18. I can participate in multiple conversations at the same time using [the medium].
19. Many conversations can occur at the same time while using [the medium].
20. It is difficult to participate in multiple conversations at the same time using [the medium].

Rehearsability

In this section, evaluate the communication medium on its ability to enable the sender to rehearse or 'fine tune' the message before sending it. For example, in a face to face communication context, it is likely to be impossible to rehearse or edit your message while you're sending it. On the other hand, in a written letter, editing the letter to ensure its intended meaning is expressed exactly is possible and preferable. Please respond to the following statements using the following scale.

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neutral				Strongly Agree

1. I can rehearse my message before sending it using [the medium].
2. I can double check my message to make sure it says what I mean to say when I use [the medium].
3. I can edit my message before sending it using [the medium].
4. Before sending a message using [the medium] I can edit it to make sure my intended meaning is conveyed.
5. I cannot rehearse my message before sending it using [the medium].*
6. It is easy to fine tune my message before sending it over [the medium].
7. It is not possible to fine tune my message before sending it over [the medium].
8. Editing the message before sending it is possible using [the medium].
9. Rehearsing the message before sending it is possible using [the medium].
10. [The medium] allows me to rehearse my message before sending it.
11. [The medium] allows message editing to occur before sending the message.
12. [The medium] does not allow me to rehearse my message before sending it.*
13. [The medium] allows rehearsal of a message before sending it.
14. [The medium] supports rehearsing of a message before sending it.

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* Reverse Scored Item

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15. [The medium] does not allow rehearsal of a message before sending it.*
16. When I use [the medium] I can rehearse my messages before sending them.
17. When I use [the medium] I cannot rehearse my messages before sending them.*
18. When I use [the medium] I can edit my messages before sending them.
19. Fine tuning the message before sending it is possible using [the medium].
20. Before sending a message using [the medium] I cannot edit it to make sure my intended meaning is conveyed.*

Reprocessability

In this section, evaluate the communication medium on its ability to enable the receiver to reexamine or process it a later time. For example, during a face to face conversation, the message itself is fleeting and cannot be directly reexamined. On the other hand, with a written letter, the message can be read and reread over and over again before responding to it. Please respond to the following statements using the following scale.

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neutral				Strongly Agree

1. [The medium] allows me to process a message several times during a conversation.
2. I can process a message repeatedly during a conversation when using [the medium].
3. It is possible to process a message repeatedly during a conversation using [the medium].
4. During a conversation, [the medium] allows me to process a message multiple times.
5. It is not possible to process a message repeatedly during a conversation using [the medium].*
6. Reexamination of messages during a conversation is possible when using [the medium].
7. Messages can be processed multiple times during a conversation when using [the medium].
8. It is difficult to process a message multiple times during a conversation when using [the medium].*
9. It is possible to process a message over and over during a conversation when using [the medium].
10. Messages cannot be processed many times during a conversation when using [the medium].*
11. During a communication event, I can process a message multiple times when using [the medium].

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* Reverse Scored Item

12. I can process a message many times during a communication event when using [the medium].
13. [The medium] allows messages to be processed many times during a conversation.
14. [The medium] allows messages to be reexamined many times during a communication event.
15. [The medium] does not allow messages to be processed many times during a conversation.*
16. [The medium] cannot support reexamination of a message during a conversation.*
17. Reprocessing of messages during a communication event is possible when using [the medium].
18. I can go back over a message in [the medium] during a conversation.
19. Processing a message multiple times is possible during a communication event when using [the medium].
20. Messages in [the medium] can be processed multiple times during a communication event.

APPENDIX B

Rotated Component Matrix from Round 1 EFA

| | Components | | | | | | | | | | | |
	1	2	3	4	5	6	7	8	9	10	11	12
EP18	**0.9625**	0.0680	-0.0237	0.1784	0.0365	0.0159	-0.0248	0.0019	-0.0153	0.0293	-0.0204	0.0703
EP9	**0.9449**	0.0933	0.0212	0.1995	0.0044	-0.0173	-0.0236	0.0276	0.1267	0.1212	-0.0179	0.0007
EP13	**0.9350**	0.0720	-0.0053	0.1857	-0.0279	-0.0228	-0.0370	0.0392	0.0763	0.2157	0.0042	0.0483
EP12R	**0.9339**	0.0091	-0.0139	0.1718	0.0684	-0.0098	0.0530	-0.0279	0.0619	0.1815	0.0387	-0.0042
EP8	**0.9312**	0.1383	-0.0587	0.2406	0.0832	0.0550	0.0287	0.0239	-0.0051	-0.0830	-0.0085	0.0213
EP5	**0.9137**	0.0556	-0.0258	0.2096	0.0888	0.0257	0.0530	-0.0875	0.0315	-0.1784	0.0353	-0.0128
EP2	**0.9114**	0.1226	0.0543	0.2913	0.0534	0.0660	0.1105	-0.0263	-0.0148	-0.0475	-0.0627	0.0192
EP19	**0.9088**	0.1105	0.1028	0.2323	0.0931	0.1015	0.0290	0.1065	-0.0661	-0.0761	-0.0690	-0.0731
EP6R	**0.9045**	0.1283	0.0339	0.2251	0.0553	0.1621	0.0931	0.0554	-0.1617	0.0620	-0.0450	-0.0096
EP20R	**0.9021**	-0.0095	-0.0749	0.2019	0.0306	0.0289	0.1150	-0.1762	0.1243	-0.0070	0.0666	-0.0394
EP4	**0.8962**	0.0889	0.0264	0.1880	0.1401	0.1067	0.0566	0.1253	-0.0294	-0.1690	-0.0078	-0.0164
EP3	**0.8878**	0.1257	0.1275	0.2433	0.1098	0.1206	0.1121	0.0677	-0.0470	-0.1673	-0.0874	0.0217
EP10	**0.8849**	0.1179	0.0121	0.1633	-0.0311	-0.0371	-0.0015	-0.0154	0.0639	0.1482	-0.0508	-0.0003
EP1	**0.8827**	0.1463	-0.0531	0.1827	0.1192	0.2707	0.0948	-0.0037	-0.0388	-0.0121	-0.0243	0.0680
EP17	**0.8512**	0.1622	0.1377	0.2145	0.1207	0.1147	0.0258	0.1349	0.0947	-0.2006	-0.0045	-0.0720
EP15	**0.8395**	0.0582	0.0434	0.3019	0.1697	-0.0336	0.0505	0.0570	-0.0432	-0.3038	-0.0009	-0.0983
EP11R	**0.8140**	0.0554	0.0165	0.1917	0.0472	0.0741	-0.0579	0.1368	0.1953	0.2812	0.0556	0.2287
EP7R	**0.8136**	0.2250	-0.0537	0.2896	0.0413	0.0992	-0.1168	0.2205	-0.0636	0.1313	0.0269	-0.1321
EP14R	0.7954	0.0116	-0.0641	0.0317	-0.0460	0.0368	-0.2288	-0.0151	-0.1047	0.0185	0.4331	-0.0335
EP16R	0.6304	0.2543	0.2450	-0.0310	0.1037	-0.0810	0.1613	-0.0500	0.0863	0.0067	0.4343	0.1131
ERH11	0.1092	**0.9378**	0.0764	0.2270	0.0647	0.0839	-0.0139	0.0466	0.0185	0.0036	0.0512	-0.0190
ERH10	0.0743	**0.9194**	0.1448	0.2190	0.0239	-0.0082	-0.1107	0.1039	0.0274	-0.0176	0.0900	-0.0201
ERH4	0.0581	**0.9109**	0.0018	0.3632	0.0528	0.0066	0.0263	-0.0035	0.0319	0.0045	-0.0443	-0.0877
ERH20	0.1510	**0.9085**	0.0818	0.3201	0.1026	-0.0212	-0.0013	0.0352	-0.0279	-0.0161	-0.0712	-0.0819
ERH3	0.1082	**0.9064**	-0.0016	0.3285	0.0888	0.1027	0.0542	-0.0044	0.0392	0.0020	-0.0215	0.0305
ERH2	0.1117	**0.9017**	0.0473	0.1547	0.1113	0.0726	-0.0664	0.0683	0.0207	0.0427	0.1442	0.0894
ERH1	0.1609	**0.8997**	0.0714	0.1644	0.1331	0.0403	-0.0687	0.0693	-0.0319	0.0320	0.1059	0.0836
ERH13	0.1022	**0.8952**	0.0522	0.3309	0.0652	-0.0323	-0.0038	0.0178	0.0163	-0.0082	-0.0489	-0.1289

ERH19	0.1758	**0.8933**	0.0813	0.3150	0.1228	-0.0039	0.0268	0.0234	-0.0608	-0.0264	-0.0816	-0.0372
ERH7	-0.0358	**0.8471**	0.0640	0.3206	-0.0517	-0.1364	0.0252	0.0033	0.0315	-0.0158	-0.0560	-0.1452
ERH16	0.1522	**0.8412**	0.1499	0.3211	0.0430	0.0295	-0.0201	-0.0246	-0.1008	-0.1262	0.0537	-0.0410
ERH14	0.0858	**0.8385**	0.0599	0.2981	0.0979	-0.0563	-0.0808	0.0280	-0.0343	0.0069	0.0768	-0.0670
ERH12R	0.1188	**0.8306**	-0.0338	0.1512	0.0229	0.3624	0.0920	-0.0572	0.0444	0.0644	-0.0111	0.0095
ERH17R	0.1210	**0.8280**	0.0078	0.1590	0.1160	0.4296	0.1256	-0.0037	0.0394	0.1096	0.0326	0.1325
ERH5R	0.0697	0.7994	-0.0585	0.2137	0.1446	0.2245	0.0467	0.0528	0.0608	0.1023	0.0762	0.2951
ERH9	-0.0544	0.7960	-0.0075	0.2200	0.0745	-0.0579	-0.0247	0.0449	0.0034	-0.0537	-0.0950	0.0374
ERH18R	0.3364	0.6696	0.0803	0.1293	0.1811	0.3649	0.2422	-0.1165	-0.0833	-0.0134	-0.0009	0.1821
ERH6R	0.0459	0.6365	-0.0986	0.1859	0.1164	0.0551	0.2371	0.3853	0.1540	-0.0081	-0.1308	0.0016
ESV8	0.0453	-0.0168	**0.9733**	-0.0496	0.0392	-0.0782	0.0658	-0.0162	-0.0082	0.0853	-0.0032	0.0215
ESV19	0.0274	0.0062	**0.9622**	-0.0805	0.0685	-0.0938	0.0377	-0.0245	0.0075	0.0342	-0.0069	-0.0612
ESV6	0.0555	-0.0173	**0.9580**	-0.0096	0.0110	0.0103	0.0652	0.0058	0.0035	-0.0279	-0.0645	-0.0904
ESV11	-0.0243	0.0807	**0.9577**	-0.0258	0.1023	0.0156	0.0035	0.0387	-0.0177	-0.0823	0.0224	0.1038
ESV4	-0.0159	0.0132	**0.9464**	0.0116	0.1169	-0.0836	-0.0634	-0.0231	0.0093	-0.0562	0.0478	-0.0110
ESV20	-0.0420	0.0617	**0.9459**	0.0038	0.1284	-0.0108	-0.1051	-0.0127	0.0631	-0.0793	0.0527	0.0994
ESV13	-0.0118	0.0370	**0.9412**	-0.0851	0.0590	-0.0089	0.0119	0.0149	-0.0714	0.0465	0.1202	-0.0854
ESV7	-0.0109	0.1126	**0.9404**	-0.0135	0.0788	-0.0898	-0.1643	0.0190	-0.0098	-0.1478	-0.0142	0.0463
ESV2	-0.0726	0.0629	**0.9356**	0.0016	0.0797	-0.1633	0.0299	-0.0837	-0.0220	0.0121	0.0392	0.0203
ESV16	-0.0156	-0.0095	**0.9297**	-0.0531	-0.0225	-0.0610	-0.0775	0.0554	0.1005	0.1908	-0.0053	-0.1051
ESV1	-0.0351	0.0520	**0.9241**	0.0497	0.1222	-0.1684	0.1508	-0.0927	-0.0252	0.0625	-0.1023	-0.0212
ESV17	-0.0353	0.0919	**0.9123**	0.0449	0.0844	-0.0897	-0.2565	0.0351	0.1018	-0.0783	-0.0100	0.0127
ESV10	-0.1156	0.1457	**0.9067**	0.0245	0.0628	0.0807	-0.2260	0.1002	0.0627	-0.0590	-0.0207	0.0195
ESV15R	0.0936	0.0583	**0.8919**	-0.0513	0.0432	0.1939	0.1655	-0.1001	-0.0265	0.0397	-0.0484	-0.0203
ESV12R	0.0056	0.0152	**0.8671**	-0.1249	0.1722	0.0892	0.2205	0.0222	-0.0238	0.0339	-0.0721	0.0047
ESV18R	0.1221	-0.1642	**0.8548**	-0.2097	0.0563	0.2069	0.2406	-0.0510	-0.0740	0.0274	-0.0945	0.0682
ESV14R	0.2072	0.0617	0.7652	0.0200	-0.0594	0.1411	0.4598	0.0973	-0.0387	-0.0775	0.1606	-0.0115
ESV9R	0.2365	0.0380	0.7288	-0.0089	-0.0456	0.1492	0.4893	0.2305	0.0091	-0.0731	0.1700	0.0640
ESV5R	0.1373	0.0390	0.6503	-0.0607	-0.0585	0.0615	0.5857	0.1561	0.1269	-0.0745	0.1858	-0.0262
ERP1	0.2302	0.2970	-0.0588	**0.8990**	-0.0218	0.0535	0.0320	-0.0020	0.0215	-0.0790	-0.0110	0.0289
ERP9	0.2459	0.3041	-0.0576	**0.8811**	-0.0479	0.0231	-0.0142	-0.0133	0.0419	0.1574	0.0611	-0.0156
ERP11	0.3010	0.2947	-0.0349	**0.8797**	-0.0358	0.0004	-0.0590	-0.0113	-0.0279	0.0882	0.0924	-0.0505

ERP12	0.2889	0.3032	-0.0347	**0.8769**	-0.0357	-0.0012	-0.0561	-0.0198	-0.0296	0.0792	0.0762	-0.0835
ERP4	0.3492	0.2923	-0.0489	**0.8722**	-0.0054	0.0421	-0.0418	0.0787	0.0699	-0.0092	-0.0223	0.0307
ERP19	0.3086	0.3532	-0.0007	**0.8714**	0.0005	0.0389	-0.0076	0.0085	0.0065	-0.0520	-0.0081	-0.0253
ERP8	0.3016	0.3498	0.0068	**0.8585**	-0.0166	0.0889	0.0412	-0.0237	0.0174	0.0691	-0.0125	-0.0539
ERP3	0.3774	0.2415	-0.0198	**0.8501**	-0.0099	0.1624	-0.0377	0.0584	0.0405	-0.0653	0.0133	0.0791
ERP5	0.1025	0.3636	0.0202	**0.8488**	0.0724	-0.0117	0.1631	-0.1106	-0.0405	-0.0744	0.0764	0.0935
ERP14	0.3253	0.3259	-0.0438	**0.8479**	-0.0096	0.0135	0.0108	0.0818	0.0122	0.0815	0.0241	-0.0309
ERP2	0.4383	0.2153	-0.0085	**0.8095**	0.0626	0.0311	0.0616	0.1476	-0.0032	-0.1361	-0.0472	0.0593
ERP18	0.3061	0.4988	-0.0079	0.7746	-0.0095	0.1363	-0.0121	-0.0022	0.0426	-0.0442	-0.0790	-0.0904
ERP20	0.2067	0.3150	-0.1122	0.7633	-0.0780	-0.0736	-0.1167	-0.0342	0.0021	-0.0668	-0.1321	0.0817
ERP7	0.3528	0.5233	-0.0365	0.6991	0.0099	0.0700	-0.0381	0.0047	0.0785	-0.0963	-0.1288	-0.1264
ERP13R	0.2869	0.3987	-0.0779	0.5942	0.0779	0.4318	0.0587	0.1304	0.0060	0.0453	0.0332	0.3145
ERP16	0.0944	0.3760	-0.2597	0.5831	0.2026	0.0594	-0.0655	-0.0771	0.1011	0.0293	-0.0720	-0.4087
ERP6R	0.2160	0.3616	-0.1726	0.5806	-0.1296	0.4894	0.0858	0.0251	0.0179	0.0065	-0.0987	0.0529
ERP10R	0.2353	0.4050	-0.1283	0.5461	-0.0015	0.3136	-0.0510	0.0914	0.0246	0.1177	-0.0705	0.3484
ETV9	0.1719	-0.0323	0.2043	0.0308	**0.9067**	0.0683	-0.0405	-0.1094	0.0674	-0.0170	-0.0500	0.1221
ETV10	0.1031	0.0188	0.1844	0.0517	**0.8882**	0.0869	-0.0364	0.1492	0.1262	-0.1254	-0.0945	0.1405
ETV6	0.0524	0.1009	0.0836	-0.0103	**0.8574**	-0.0455	-0.0076	0.2346	0.2235	-0.0016	0.0019	-0.1048
ETV20	0.2083	0.0345	-0.0731	0.0700	**0.8234**	0.0392	0.0682	0.0430	-0.0644	0.2822	0.0652	0.0442
ETV5	0.0048	0.0949	0.1444	-0.0759	**0.7962**	-0.1850	0.0152	-0.1972	-0.0005	-0.2820	0.1811	-0.0261
ETV11	0.1784	0.1148	0.1467	0.0194	0.7948	-0.0592	-0.0251	0.1738	-0.2545	-0.0551	-0.3403	-0.0960
ETV8	-0.1219	0.1979	0.1100	0.1590	0.7816	0.0798	-0.2558	0.2011	-0.2871	0.0411	-0.1413	0.0014
ETV3R	-0.0089	0.2296	0.1185	-0.0658	0.7714	0.1817	0.0115	-0.2558	-0.0693	-0.2062	-0.0258	0.1555
ETV4R	0.0787	0.0658	0.1381	-0.1871	0.7666	0.1694	0.2678	-0.1395	-0.1233	0.0835	0.0961	-0.2498
ETV13	0.1423	0.0730	-0.0210	-0.2508	0.7487	-0.3401	-0.0712	-0.0949	0.2022	0.2213	-0.0527	0.0649
ETV12	-0.0615	0.0886	-0.0573	0.0592	0.7240	0.0529	-0.1135	-0.0692	-0.1800	0.5594	0.0130	-0.0073
ETV2	0.0822	0.2457	0.0854	0.0272	0.7040	-0.2819	0.1155	0.2989	0.2863	-0.0999	0.2513	-0.0076
ETV19R	0.3503	-0.0196	0.1832	0.0929	0.6883	0.2094	0.0457	0.2318	0.3892	-0.0204	-0.0703	0.0038
ETV7	-0.1699	0.0547	0.0375	-0.0463	0.6841	-0.0887	-0.0582	-0.0609	-0.5378	-0.0477	0.1253	-0.0562
ETV1	0.0933	0.3553	0.0718	-0.0548	0.6607	-0.2514	0.1217	0.3769	-0.0793	0.0128	0.2985	-0.1078
ETV15R	0.3636	0.1680	0.1061	0.1018	0.6030	0.4006	-0.0397	0.1346	0.2351	0.0993	0.0173	-0.2625
ERP15R	0.3375	0.1998	-0.2133	0.2562	-0.1255	0.7603	0.1230	-0.0559	0.0006	-0.0420	-0.1781	0.0396

ERP17R	0.2039	0.2908	-0.1004	0.5477	0.0235	0.5487	0.0387	0.0432	-0.1353	0.0667	0.2386	-0.0436
ERH15R	0.3372	0.5139	0.0890	0.2249	-0.1141	0.5198	-0.2006	0.1810	0.0964	-0.0763	0.1141	-0.1071
ETV17R	0.4727	0.4093	0.0909	-0.0091	0.2747	0.5069	0.1044	0.2301	-0.1484	0.1126	0.0107	0.0312
ETV18R	0.4344	0.2910	0.0909	0.0964	0.3007	0.4736	0.1519	0.2532	0.1989	-0.0265	0.3258	-0.0993
ESV3R	0.2510	0.0403	0.5241	0.0047	-0.0097	0.1130	0.7145	0.0970	0.0127	0.0075	-0.1410	0.0138
ETV16R	0.3895	0.2168	0.0949	0.0503	0.2679	0.2300	0.1064	0.6218	-0.0316	-0.0974	-0.0569	-0.0336
ETV14	0.1914	0.4252	-0.0285	0.0044	0.4526	0.0056	0.1150	0.5884	-0.0445	0.1142	0.0745	0.1760
ERH8	0.1011	0.5764	0.1796	0.2155	0.1773	-0.1098	0.0293	-0.1354	0.6144	-0.1333	0.1336	-0.0663

Note: Item codes reflect the medium (E), the construct (RP), the item number (1), and an indicator that the item is reverse scored if necessary (R). For example, the item code ESV15R indicates that that item assessed the participants' perceptions of e-mail's (E) Symbol Variety (SV), was item number 15 for Symbol Variety in Appendix A, and was reverse scored (R). Also note that for the 5 components that exhibited acceptable factor scores, factor scores over 0.8 are bold, with the exception of the final bolded loading for component 5 for item EIF5 which was .7962.

APPENDIX C

Retained Items

Transmission Velocity

1. Rapid communication in both directions is possible with [the medium].
2. It takes a long time to give feedback when I use [the medium].*
3. I can give instantaneous feedback when I use [the medium].
4. [The medium] allows me to receive immediate feedback from the person I'm communicating with.
5. [The medium] is fast to provide feedback from the person I'm communicating with.

Symbol Sets

1. [The medium] can communicate information in a lot of different ways.
2. The number of ways information can be communicated using [the medium] is high.
3. [The medium] allows me to communicate information in many ways.
4. Information can be communicated in many ways with [the medium].
5. It is possible to communicate information in many ways using [the medium].

Parallelism

1. [The medium] can carry many simultaneous conversations.
2. Several conversations can exist at the same time while using [the medium].
3. It is difficult to have multiple conversations at the same time while using [the medium].*
4. [The medium] supports multiple simultaneous conversations.
5. I can participate in multiple conversations at the same time using [the medium].

Rehearsability

1. I can edit my message before sending it using [the medium].
2. Before sending a message using [the medium] I can edit it to make sure my intended meaning is conveyed.
3. [The medium] allows me to rehearse my message before sending it.
4. [The medium] allows message editing to occur before sending the message.
5. Before sending a message using [the medium] I cannot edit it to make sure my intended meaning is conveyed.*

Reprocessability

1. [The medium] allows me to process a message several times during a conversation.
2. During a conversation, [the medium] allows me to process a message multiple times.
3. It is possible to process a message over and over during a conversation when using [the medium].
4. During a communication event, I can process a message multiple times when using [the medium].
5. I can process a message many times during a communication event when using [the medium].

APPENDIX D

Activity Diagramming Narrative:

When a student logs into the University's METRO system, he/she checks their class schedule and looks up a class to add to their schedule. When the student checks their schedule, they can either just view their schedule, or they can print their schedule. If they choose to print their schedule, they can either print it with their name, or without their name. Once they make the choice to print or not print their name, they then print their schedule. When the student looks up a class to add to their schedule, if the class is available, the student enters the class ID on the registration form. If the class is not available, the student checks to see if other classes are available. If any other classes are available, those class IDs are entered on the registration form. Once the registration form is complete, the student submits their registration, and views or prints their schedule, they can log out of METRO.

APPENDIX E

Measurement Scales and Instructions

For the following questions, we will be asking you about your perceptions of the tutorial. When the question asks about the "system," it is referring to the window that contained the information on the computer screen.

Knowledge Possessed (Subjective)

1. To what extent have you learned about activity diagramming from this tutorial?
2. I learned a great deal about activity diagramming from this tutorial.
3. I didn't learn very much about activity diagramming from this tutorial.
4. I could complete another diagramming task without referring back to the tutorial.

Absorptive Capacity

5. I had a vision of what I was trying to achieve by using the tutorial.
6. I had previous information on activity diagramming.
7. I had the necessary skills to complete the activity diagramming task.
8. I had the technical competence to absorb activity diagramming.

Motivation to Learn (Personal Relevance)

9. This kind of diagramming task is useless to me.
10. This kind of diagramming task is irrelevant to me.
11. This kind of diagramming task is not personally important to me.

Motivation to Learn (Subjective Competence)

12. I am good at doing diagramming tasks such as this one.
13. I am competent to do these kinds of diagramming tasks.
14. These kinds of diagramming tasks are easy for me to do.
15. It is difficult for me to do these kinds of diagramming tasks.

Motivation to Learn (Task Attractiveness)

16. I dislike these kinds of diagramming tasks.
17. I am looking forward to working on more of these diagramming tasks.
18. I find these kinds of diagramming tasks appealing.

Motivation to Learn (Valuing Subject)

19. Understanding the subject matter of systems analysis and design is not personally important to me.

20. I am very interested in the content area of systems analysis and design.
21. I think the course material in this class is useful for me to learn.
22. I dislike the subject area of this course.

APPENDIX F

Activity Diagramming Narrative for Time 2:

Imagine you are shopping online. You first visit the web site from where you want to purchase the items. If you are an existing customer, you logon. Otherwise, you will need to create your user name and password, and then create the customer profile. After you have logged on (or created the profile), you search for the items. You then place the items in the shopping cart, and then checkout.