Knowledge Transfer in Virtual Information Systems Development Teams: an Empirical Examination of Key Enablers

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Abstract

Knowledge transfer among geographically separated members is recognized as a critical ingredient for collaborative accomplishment of knowledge work in virtual teams. However, due to the "localness" of knowledge, such transfer of knowledge is believed to be inherently problematic, and thus, it is important to develop a solid understanding of the factors that enable knowledge transfer in such contexts. Drawing on existing literature on knowledge management and virtual teamwork, we identify 4 Cs (communication, capability, credibility, and culture) associated with individuals who are found to transfer significant amounts of knowledge to remote members, and test the 4 Cs in the context of US-Norwegian virtual teams engaged in systems development. A number of implications and directions for future research are also suggested.

1.0 Introduction

Few would question the validity of the assertion that we currently live in a knowledge society [25]. Organizational scholars argue that knowledge, described by Nonaka as a "multifaceted concept with multilayered meanings" is one of the most important resources that "contributes to the competitive advantage of an organization" [27]. Hiebler argues that only those organizations that can develop best practice for managing this complex concept of knowledge will be the ones to "ride this competitive wave." [15]

These statements appear to be especially true in the case of emergent organizational forms such as virtual teams engaged in knowledge work. Virtual teams are ICT-mediated temporary work-groups often consisting of members with diverse backgrounds and areas/levels of expertise, drawn from different geographical locations and charged with the responsibility of completing a project within a limited time frame [20, 22, 31]. In recent times, due to a variety of reasons such as globalization, competitive pressures, differential personnel costs, availability of talent in different parts of the world, and enhanced capability of telecommunications infrastructure, knowledge work such as Information Systems Development (ISD) is increasingly being undertaken in virtual teams [7, 17]. One of the key prerequisites for enabling collaboration among team-members with diverse backgrounds in terms of domains and levels of expertise is the members' ability to create a sense of mutuality and a shared frame of reference [10, 32, 38]. Clearly, this would necessitate a transfer of knowledge from one team-member to another (i.e., transmitting knowledge to and absorbing knowledge from each other). However, such transfer of knowledge across space and time would appear to be fairly problematic, in light of findings regarding the "localness of knowledge." Davenport and Prusak explain the implications of localness of knowledge as follows:[10]

> People usually get knowledge from their organizational neighbors. The knowledge market depends on trust, and individuals usually trust people they know. Face-to-face meetings are often the best way to get knowledge.. reliable information about more distant knowledge sources is not available. Also, mechanisms for getting access to distant knowledge tend to be weak or nonexistent.

Unfortunately, given the explosion in the use of virtual teams engaged in knowledge work such as ISD, it is no longer sufficient to merely state that geographical distance poses a major barrier to knowledge transfer. Rather, understanding the enablers/inhibitors of knowledge transfer when members aren't able to meet face-to-face becomes an imperative that has been largely

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ignored till date [17], which is somewhat surprising given the interest in and acknowledged importance of knowledge transfer within the Knowledge Management research community [1, 25, 30].

In this study, we take a small step toward filling this void in the literature, by identifying and empirically examining the key factors associated with individuals in a virtual ISD team who are viewed by remote members in different knowledge localities as significant contributors (i.e. sources) to their (i.e. recipients') ISD related knowledge. Specifically, our research question guiding this study is: ***What are the key characteristics and behaviors associated with an ISD virtual team-members who are able to transfer substantial amount of knowledge to geographically-separated team-members?***

We believe that our study makes an important contribution to the existing KM literature. By providing empirical evidence showing that knowledge transfer across time and space *is possible*, and pointing to some desirable characteristics and behaviors of individuals (potential knowledge sources) from whom remote members absorb knowledge, the paper complements existing KM research that has generally investigated knowledge transfer within an organization or within a knowledge locality.

The rest of the paper is organized as follows. In the next section, we provide a brief discussion of the knowledge transfer literature, followed by the development of our theoretical model. Thereafter, we discuss our research methods and present our results. Next we provide a discussion of the results, limitations of the study, and the implications of the study, both theoretical and practical. Finally, we conclude with some directions for future research.

2.0 Background

Knowledge Transfer

Nonaka suggests that one of the most important aspects of knowledge management is the transfer of knowledge from one set of individuals to another[25]. Szulanski defines knowledge transfer as the process where "complex, causally ambiguous set of routines" are "recreated and maintained" in a "new setting."[35] Argote and Ingram define knowledge transfer as a "process through which one unit (e.g. group, department, or division) is affected by the experience of another."[3] In the context of information systems development, we define knowledge transfer as the *transfer of source's ISD-related knowledge to the recipients*. ISD-related knowledge includes technical know-how, as well as knowledge regarding IS project management [21]. Knowledge transfer can occur across multiple levels, such as between individuals, groups, and organizations [3, 19]. It can be argued that with the increase in globalization, knowledge transfer may also occur between individuals, groups, and organizations, that are separated by geographic distances and national cultures [37]. Knowledge management researchers have attempted to investigate knowledge transfer at all of the three levels, though mostly within local settings, and seldom across cultures.

At an individual level, the knowledge transfer literature has examined the transfer of expert knowledge to novices in a variety of different contexts [6, 12]. The outcome measure most widely used in these studies has been the individual learning construct. At an organizational level, researchers have examined the knowledge transfer process between independent firms, strategic alliances, and acquisitions [40, 33]. The common outcome measures used in these research studies are the speed of knowledge transfer, organizational learning, productivity and profitability. The research on knowledge transfer using the group, team, and departmental level of analysis has been relatively scarce. A few studies that have examined transfer using a group/team/unit level analysis have investigated the impediments to the transfer of knowledge [34].

Szulanski suggests that "knowledge transfers are often laborious, time consuming, and difficult" and argues that it is important to understand what are the impediments to knowledge transfer, in order to make the process more effective and the outcomes more favorable [34]. The process of knowledge transfer may become even more daunting, in situations where knowledge is being transferred across time and space such as in a virtual team [10], and hence requires further investigation. The five basic elements of knowledge transfer are the source, recipient, channel, message, and context [35]. Characteristics of the source (such as capability, reliability, etc.) have been identified as important factors that affect knowledge transfer. Specifically, it has been suggested that a source who is viewed as capable, will be more successful in transferring knowledge by influencing the behavior of the recipient [28]. The credibility of the source, in terms of the trustworthiness and the reliability [34, 10] has also been shown to influence knowledge transfer. Further, in a study examining knowledge transfer in international acquisitions, Bresman, Birkinshaw, and Nobel concluded that the extent of communication that the source has with the recipient is a significant predictor of knowledge transfer [4]. Finally, for knowledge transfers across national boundaries, the culture (national) of the source has been seen to be an important enabler/inhibitor [4, 10]. In the following section, we expand on these ideas to develop our theoretical model.

3.0 Theoretical Model: The Four Cs Influencing Knowledge Transfer

Drawing on the above discussion of the knowledge transfer literature and focusing solely on the

characteristics of the source, we present the *Four C Framework* of knowledge transfer[1] across time and space, wherein we argue that in a virtual ISD team, the characteristics of an individual that positively affect his/her extent of knowledge transfer to his/her remote team members, are their ISD capability (with respect to their remote team members), their credibility, their communication extent, and their national culture (See Figure 1).

Capability (ISD) Difference and Knowledge Transfer

According to experts, a critical factor enabling knowledge transfer in organizations is the presence of "smart people" in the organization [10] who have the specific domain expertise necessary to accomplish the work. A source with a greater reservoir of knowledge has a potential to transfer more knowledge to the recipients than the source with a limited knowledge-base. In addition, a knowledgeable source, because of his/her understanding of the domain, is better equipped to facilitate the knowledge transfer process [40]. Further, Perloff contends that an expert is more likely than others to influence the behavior of the recipient, which is attributable to the absorption of an expert's knowledge by the recipient [10].

In any knowledge work, especially Information Systems Development (ISD), there are two arenas where expertise is particularly valuable: 1) "hard" technical, which includes programming and database skills; and 2) "soft" analysis & project management skills which includes requirement elicitation, relationship management, resource allocation and tracking, and application of systems development methodologies [15, 21, 10]. Such knowledge "resides in people's minds" [10], and needs to be shared with other members in order to create a shared frame of reference necessary for collaborative development of systems across time and space [38]. Consistent with the views of Von Krogh, Ichijo, and Nonaka [37], who state that "The difference in knowledge expertise between corporate team of experts and local organizations drive knowledge transfer," we expect that individuals who have higher level of expertise than their remote counterparts would act as the source of knowledge transfer across "knowledge localities" in a virtual team.

Hypothesis 1*: In a virtual ISD project, greater the difference in ISD capability between an individual and his/her remote members, greater the extent of knowledge transferred by the individual (i.e. the source).*

[1] We do not claim that these are the only factors that affect knowledge transfer across time and space. However, these factors seem to be featured prominently in the existing knowledge management literature. It is also worth mentioning that in this study, we view knowledge not as a process, but as a product that can be transferred from one person to another.

Credibility and Knowledge Transfer

The construct of credibility consists of two related concepts of trust and reputation that have been identified in the literature as important determinants of effective knowledge transfer. *Trust* has been portrayed as a fundamental enabler of knowledge transfer [10]. When the source is perceived as untrustworthy, the recipient may consider the knowledge to be unreliable and as a result they are less likely to use/internalize the knowledge communicated by the source [35].

Davenport and Prusak believe that "reputation is a proxy for value that we use to evaluate the flood of information coming at us [10]. We don't have time to look carefully at everything, so we select what we think will be worthwhile based on the reputation of the sender." According to the same authors, reputation is best gauged by looking at "performance" of the individual rather than hierarchical "status" in the organization. In a virtual team, performance becomes an even more important surrogate of reputation, given that 1) members may have no history of working together with remote members, 2) there is no universally accepted hierarchical status of any individual because of the temporary and diverse nature of team membership, and 3) the social cues traditionally associated with competence and reputation are filtered out in the electronic communication channels [31, 20].

In summary, when a source of knowledge is not perceived as *credible* (i.e. trustworthy and reputable), the advice and exemplars offered by the source are likely to be challenged and resisted [39], thereby reducing the extent of learning.

Hypothesis 2*: In a virtual ISD project, individuals who have a high level of credibility will transfer more knowledge to remote members.*

Communication Extent and Knowledge Transfer

The knowledge management literature provides strong emphasis on the importance of communication on knowledge transfer. Past research suggests that frequent communication alleviates anxiety caused by mis-information and facilitates interaction between individuals, which in turn, assists in the creation of a shared meaning or context within which the transfer process can be facilitated [35]. On the other hand, it has been shown that infrequent communication can create hardship during the knowledge transfer process [35]. In fact, Davenport and Prusak state, that a second key factor enabling knowledge transfer is the extensive communication between the source and the recipient [10]. They further argue that "in a knowledge-driven economy, talk is real work". They suggest that it is time to discard the traditional management principle of "stop talking and get to work," and begin the era of "start talking and get to work." Von Krogh, Ichijo, and Nonaka also argue that conversations play a very important part in knowledge-sharing [37]. According to them, through extended discussions, an individual's ideas, viewpoints, and beliefs

are shared with, and made available to others. The importance of "talk" is also highlighted through the use of the metaphor of the "water cooler." The "water cooler effect" suggests that conversations that develop in and around a water cooler or in a cafeteria significantly enables knowledge transfer [10]. While traditionally it has been believed that such conversations lead to lack of productivity, in recent years it has been found that water cooler conversations are mostly work-related, though some social information is also shared [10]. Citing Alan Webber, Davenport and Prusak suggests that communication is the main mode by which workers "discover what they know," and "share it with their colleagues." [10]

The above discussion suggests that in a virtual team too communication will play an important role in knowledge transfer. While a water cooler conversation in the truest sense may not be possible in a virtual team, an individual who has a high volume of communication in terms of increased participation in chat sessions and high number of message posts in threaded discussions, will end up in transferring more knowledge to his/her remote team members.

Hypothesis 3a*: In a virtual ISD project, individuals with a high extent of communication will transfer more knowledge to remote members.*

Davenport and Prusak argue that "the impersonality of groupware allows anyone to post information and invites anonymous access to that information [10]. However, it does not create the same confidence in quality of knowledge that personal acquaintance and reputation can inspire" thereby negatively influencing the *absorption* of knowledge, which is an *important aspect of knowledge transfer*. In other words, it is argued here that communication by a source with a higher level of credibility will result in a higher level of knowledge transfer.

Hypothesis 3b*: In a virtual ISD project, communicative individuals who have a high level of credibility will transfer more knowledge to remote members.*

Culture and Knowledge Transfer

In a cross-cultural interaction (such as in a global virtual team), one of the primary factors that may affect the sharing of knowledge is the national culture of the knowledge transferer [4]. Culture is the "collective programming of the mind that distinguishes the members of one group or category of people from another," and is usually manifested in one's values, behaviors, and actions [16]. Lyles and Salk reported that cultural differences often affected the flow of information and learning[23]. Simonin argues that the cultural differences between the source and the recipient can impede the knowledge transfer process [33]. Walsham also suggests that knowledge sharing is heavily dependent on cultures, due to the differences in the notion of knowledge itself, and the nature and form of knowledge transfer. The cultural differences, often enacted as differences in attitudes towards system development may also have some effect on knowledge transfer [38].

Hostede's variables of individualism and collectivism, which is argued to be an important "dimension of cultural variation" [4], may be used to explain the differences in knowledge transfer between cultures[2]. The variables of individualism/collectivism refer to the "relationship between the individual and the collectivity that prevails in a given society" [16]. Members of individualistic societies view themselves as independent and are motivated by their own thoughts and preferences. They hence have less incentive to share information and knowledge with others. Individualism/collectivism affect the way an individual thinks, and influences the way an individual processes, interprets, and perhaps even shares knowledge [4]. In a work environment, members from a more individualistic society believe that "withholding information" is the key to success and prefer to "venture out on their own" [16]. On the other hand, members from less individualistic societies (i.e. more collectivist societies) believe that success depends on the ability to share knowledge with others, and they prefer to involve others in each and every aspect of their work. From the above discussion, it can be argued that virtual team members from less individualistic societies, believing in the importance of sharing, will transfer more ISD-related knowledge to their remote team members[3].

Hypothesis 4*: In a virtual ISD project, individuals from more collectivist cultures will transfer more knowledge.*

4.0 Research Methods

The purpose of the research design was to test the 4C framework of knowledge transfer proposed in the previous section of this paper. Virtual teams involving student-members from a large US university and a large Norwegian University were formed.

Sample

The sample consisted of virtual teams comprising of 4-5 students enrolled in a systems analysis and design course in a large US public university who were randomly teamed up with 4-5 students enrolled in a similar course in a Norwegian university. There were a total of nine teams with a *useable sample size* of 64 (an *individual*

[2] An important point to be noted here is that cultural variables (such as individualism/collectivism), though considered as properties of national cultures, are increasingly being applied by researchers at an individual/group level (Ang and Slaughter 2000).

[3] In the specific case of our project, while both the US and Norway rank relatively high on individualism (with ranks of 1 and 13 respectively), we argue that the differentials in the individualism scores (91 and 69 respectively) are sufficient to result in differences in knowledge transfer.

level of analysis was applicable to the research question in this study). We would like to emphasize that a study involving student subjects is considered appropriate for research investigating psychological/social processes (as in the case of this study), even though there may be limits to generalizability [24].

Design

The teams were required to develop application systems to solve business problems for "real" organizations located across the globe (such as in the home state of the US university, and the home city of the Norwegian university, in addition to Finland, South Africa, and India).

The communication between the US and the Norwegian team-members occurred primarily through the use of an electronic communication tool (WebCT), which allowed online chats, document sharing, and threaded discussion. In addition to WebCT, e-mail and (two pre-scheduled) videoconferences were also used. To summarize, communication among team-members from the two locations was *predominantly virtual*, and did not involve any face-to-face interaction, except twice through the electronic media (videoconferencing).

Data Collection

Data for this study was collected using online questionnaires. These questionnaires were administered to the virtual team members at two different points during the project: before the start of the project and during the initial stage (i.e. at the end of the first month, soon after teams had submitted the detailed system proposal).

Measures

We measured our dependent variable, the extent of knowledge transferred by a source by asking remote recipients about their extent of learning (from the source). Specifically, two items were used to measure the extent of knowledge transfer. The first item asked each team member to specify on a scale of 1 (Not at all) to 7 (to a great extent), the extent to which they had learnt technical-ISD related skills from each of their team members (including remote team members). The second item asked each member to specify on a scale of 1 (Not at all) to 7 (to a great extent), the extent to which they had learnt managerial/behavioral ISD related skills from each of their remote team members. From this we computed the extent of knowledge transferred (including technical and managerial/behavioral ISD issues) from each individual to his/her remote members taken together[4].

To measure the independent variable of differences in ISD capability, we first computed the capability level for each individual (say, C1). The ISD capability construct comprised of the technical ability and the IS project management ability, which was measured using items in a self-reported pre-questionnaire (See Table 1). Next, we computed the mean technical and IS project management ability of the remote team members for each individual team member (say, C2). Finally, the difference between C1 and C2 was used as the independent variable.

Credibility was measured using the constructs of trust and performance. Each individual was asked to rate each of his/her remote team members on their trustworthiness and their performance in the project at that point of time. Thus, for a team of 8 members (with four remote team members), in most cases, for each individual we received 4 measures of trust and performance from remote members.

Extent of Communication was also measured by asking each individual team member to specify the extent of communication they have had with each remote team member.

Culture was coded as 0 or 1 based on whether the individual was from the US or was from Norway.

Analyses and Results

The analysis was conducted in two stages. In the first stage, we validated the instruments being used in the study (See Table 1 for the reported reliabilities)[5]. A first-order confirmatory factor analysis (CFA) using structural equation modeling was conducted to ensure the validity of the items for technical ability, IS project management ability, knowledge transfer, and credibility. Consistent with the views of Anderson and Gerbing [2], it is argued that a CFA using structural models will help in establishing the uni-dimensionality of the indicators and thus increase the validity of the instrument [26]. Results indicated a good fit of the model with the data (See Table 2). Further, all of the items loaded on the relevant factors at $p<.001$. Next, a second-order factor analysis was conducted to ensure that both technical ability and IS project management ability indeed loaded on the construct of ISD Capability. As the results suggested, technical ability loaded on ISD Capability at $p< .001$, and IS project management ability loaded on ISD Capability at $p< .05$ (See Table 3).

In the second stage, a linear regression was used to assess the effect of ISD Capability, Credibility, Communication, and Culture (taken simultaneously) on knowledge transfer. In addition, to assess the moderating role of credibility on communication's effect on knowledge transfer, an interaction term (Credibility * Communication) was computed. In Table 4, we show the descriptive statistics for the model, and in Table 5, we report the results obtained by regressing knowledge transfer on the independent variables. The variance inflation factor (VIF) and the condition index (CI) were both below the recommended range of 10 and 30 respectively [13], suggesting that our model did not suffer from multicollinearity.

Hypothesis 1 suggested that individuals with higher capabilities with respect to their remote team members

[4] We operationalized the knowledge transferred by an individual as the "mean" of the extent of learning of the remote team members from this individual (See Figure 2).

[5] Complete instrument is available upon request.

would transfer more knowledge. Our results do not support the hypothesis (H1: b = -.262, p = .056). Hypothesis 2 suggested that individuals who have high credibility will transfer more knowledge to their remote team members (H3: b = -.003, p = .857). This hypothesis was also not supported. We found support for hypothesis 3a, which suggested that individuals that had a high extent of communication with their remote team members, transferred more knowledge to their remote team members (H2: b = .791, p = .000). Moreover, Hypothesis 3b, where we argued that communicative individuals with high credibility, will transfer more knowledge, was supported (H4: b = .147, p = .047). Finally, our hypothesis regarding the effect of culture on knowledge transfer was also supported. Results suggested that individuals from relatively less individualistic cultures (i.e., more collectivist cultures) transferred more knowledge (H5: b = .763, p = .003).

5.0 Discussion

Revisiting Results

To summarize, our results indicate that for an individual to be perceived as a significant knowledge transferer, he/she should:

- Extensively participate in conversations, as indicated by the communication extent
- Be perceived as credible due to trustworthy behaviors and high performance
- Hail from a relatively more collectivist culture

Contrary to expectations, differences in capability did not seem to enhance, but, in fact, seemed to undermine the transfer of knowledge. While this negative relationship between differential capability and extent of knowledge may appear perplexing initially, several potential explanations exist. It is plausible that members with lower skills than their remote members, in attempting to be accepted as a valuable contributing member of the team, may have been more motivated to "flaunt" or share their knowledge as part of their impression management, which is not uncommon in a virtual team context. In contrast, the more skilled members who may feel "secure" about their contribution are less compelled to prove their worth and as a result do not try as hard to share their expertise. In other words, a team-member's motivation (or lack there of) to be accepted and valued in the group could be responsible for enhanced knowledge transmission (or at least creating an impression of enhanced knowledge transfer), some of which may have been absorbed by remote members. Another potential explanation is that the more knowledgeable and skilled members may be conveying their knowledge in forms that are incomprehensible to a less experienced or less skilled team member, consequently reducing the absorption of the knowledge transmitted, and thus the overall extent of knowledge transferred [8]. Yet another alternative explanation for the failed positive relationship between differential capability and knowledge transfer is that highly experienced individuals may be unable to easily explicate knowledge into forms that can be easily transferred. This often happens because knowledge of highly skilled individuals or experts is embodied in their action, and it may be very difficult to separate the knowledge from their actions [10]. Clearly, further research needs to be undertaken to investigate this apparent anomaly between the dominant view in the literature and the study's findings.

Another point worth highlighting is that credibility, by itself, did not increase knowledge transfer, though credibility did contribute positively to knowledge transferred by a communicative source. The lack of a direct effect of credibility can be attributed to the fact that the construct was measured during an early stage of the project. It is also possible that the knowledge being shared during this phase of the project was mostly explicit, and thus communication was the primary vehicle through which it was transferred; credibility of source merely helped enhance the absorption of knowledge by the recipient.

Limitations

The knowledge management literature suggests that the recipient's characteristics such as the absorptive capacity [8] and the experience, and the type of knowledge, are important predictors of the extent of knowledge transfer [35, 33]. In this study, we have focused on source characteristics and behaviors rather than recipient characteristics that has received more attention in the literature. The study could thus be faulted for not contributing to a "cumulative tradition" in knowledge transfer. We would like to submit, however, that our work (with focus on the source) can be more valuable to the knowledge management community than a study that empirically examined (yet again) the established knowledge about recipient characteristics. In any case, given the lack of research on knowledge transfer in virtual teams, the empirically validated model presented in the study can potentially provide a good foundation for further investigation.

Another limitation of this study is the fact that it involved only virtual teams having dyadic configurations, with members representing just two different cultures. The process of knowledge transfer could get even more challenging if the members were located in more than two locations, involving greater cultural diversity.

Finally, the limited sample size (64) and the use of student subjects could have had some effect on the results. We would like to note, drawing on prior research, that student subjects with appropriate backgrounds are believed to be similar to typical working professionals [11].

Despite its limitations, this study empirically provides statistical evidence of the factors that affect knowledge transfer in teams separated by time and space,

which has been sorely lacking in the knowledge management literature [17]. The systems development context adopted here makes the study even more valuable to the IS discipline.

Implications

As mentioned earlier in the introduction, we believe that our study complements existing knowledge management research that has generally investigated knowledge transfer within an organization or within a knowledge locality. It provides empirical evidence showing that knowledge transfer i*s* possible in virtual contexts, and presents a test of the *4C framework of knowledge transfer* which points to key characteristics and behaviors of individuals (potential knowledge sources) who are likely to transfer knowledge.

From a practical point of view, our findings suggest that, while virtual teams need highly skilled individuals to accomplish certain specialized tasks, it would be dangerous to assume that such individuals are the primary sources of knowledge for team-members located elsewhere. Instead, organizations using virtual teams need to consciously encourage members to communicate, recognizing that in the new economy, conversations are the most important form of work and are the way knowledge workers discover what they know, "share" it with their colleagues, and in the process create new knowledge for the firm. It is also important for virtual team participants to be aware of on-line trust building strategies, and ensure that their performance is visible to remote members. Finally, if feasible, individuals who are anticipated to be important sources of knowledge for remote members should be recruited from collectivist cultures, or they should have collectivist traits, or be inculcated with collectivist assumptions and values.

6.0 Future Directions and Conclusions

The topic of knowledge transfer, especially between individuals within organizations, has received considerable attention among researchers. However, not much research has been undertaken to examine knowledge transfer within groups, especially those that span across time and space (i.e. virtual teams). *Focusing on the characteristics of the source*, this study identifies important potential enablers of knowledge transfer in systems development virtual teams.

Future research could focus on examining the role of the characteristics of the recipients (such as absorptive capacity), and the nature of the knowledge on knowledge transfer. Research could also be undertaken to compare the findings of this study with factors enabling knowledge transfer in face-to-face ISD teams. This will enable researchers to isolate the enablers/inhibitors that are *unique* to knowledge transfer in virtual teams.

A variety of knowledge taxonomies, based on knowledge levels (data, information, knowledge, wisdom), knowledge types (descriptive, procedural, reasoning), and knowledge modes (explicit and tacit) have been suggested in the literature [18, 29, 36]. However, for the purposes of this study, instead of using a more general type of knowledge, we have adopted a taxonomy (technical vs. managerial/ behavioral) that is relevant to our context (i.e. ISD).

Finally, in this study we use a variance model in examining the enablers of knowledge transfer in virtual teams. We believe that the next step should be to take a more process approach, and uncover how the process of knowledge transfer unfolds in virtual environments, especially as the virtual teams evolve through different stages of development.

In conclusion, we reiterate that effective knowledge transfer is critical to the formation of a shared frame of reference in organizations, particularly in those separated by time and space. Yet, there has been limited empirical work undertaken on this topic. We hope that our study, in identifying key characteristics and behaviors associated with knowledge transferers across time and space, provides a useful starting point for further research in this area.

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TABLE 1: QUESTIONNAIRE ITEMS

Constructs	Reliability (Cronbach's Alpha)
KNOWLEDGE TRANSFER	.95
CAPABILITY • Technical Ability • IS Project Management Ability	.79 .75 .79
CREDIBILITY	.84
COMMUNICATION (Single item, so no reliability was calculated)	--

TABLE 2: FIRST-ORDER CONFIRMATORY FACTOR ANALYSIS RESULTS

Measurement Model	Range of Standardized Factor Loadings	GFI	NFI	CFI	IFI	RMSEA	$\chi^2_{(d.f., p\text{-}Val)}$
Capability (Technical Ability and IS Project Management Ability, Credibility, and Knowledge Transfer)	.54-1.03	.82	.78	.91	.91	.09	$\chi^2_{(71,\ p < 0.01)} = 108.4$

TABLE 3: SECOND-ORDER CONFIRMATORY FACTOR ANALYSIS FOR CAPABILITY

Coefficient	Capability
Technical Ability	.93**
IS Project Management Ability	.28*

[a] Overall model fit: χ^2 (34) = 55.19, $p < 0.05$; GFI= .85; NFI= .76; CFI= .89; IFI= .89, RMSEA= .10
** $p < 0.001$.
* $p < 0.05$.

TABLE 4: DESCRIPTIVE STATISTICS

Construct	X1	X2	X3	X4	X5	X6
Knowledge Transfer (X1)						
Capability (Technical + IS Project Management) (X2)	-.295					
Culture (X3)	.179	-.150				
Communication Extent (X4)	.692	.311	-.169			
Credibility (X5)	.614	-.073	.225	.764		
Credibility * Communication Extent (X6)	.056	.099	-.129	-.083	-.194	
Mean	1.78	-.001	.39	3.21	4.15	.85
Standard Deviation	1.21	.75	.49	.1.16	.98	1.38

TABLE 5: REGRESSION ANALYSIS

Variable[a]	Coefficient (Standard Error)	Hypothesis Support
Capability (Technical + IS Project Management)	-.262** (.134)	No
Culture	.763*** (.246)	Yes
Communication Extent	.791*** (.158)	Yes
Credibility	-.003 (.189)	No
Credibility * Communication Extent	.148** (.073)	Yes

a. Dependent Variable- Knowledge Transfer (R^2=.619; Adjusted R^2 = .587)
***- < .01
**- < .05
*- < .10

FIGURE 1: THE FOUR Cs OF KNOWLEDGE TRANSFER (RESEARCH MODEL)