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An Exploratory Investigation of the Development of Mutual Knowledge in Global Virtual Project Teams

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AN EXPLORATORY INVESTIGATION OF THE DEVELOPMENT OF MUTUAL KNOWLEDGE IN GLOBAL VIRTUAL PROJECT TEAMS

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Abstract

The use of virtual project teams (VPTs) is increasingly prevalent in organizations today. This increasing reliance on VPTs introduces obvious challenges relating to virtual team members' ability to communicate and effectively share knowledge particularly when the project is highly complex. These tasks are further exacerbated by the nature of virtuality itself and the attributes of the collaboration technology used. In view of this, some researchers have argued that mutual knowledge is an important factor in engendering effective virtual team interactions which in turn can ultimately impact VPT performance. This paper presents an exploratory empirical study of how mutual knowledge develops in VPTs through transactive memory processes and the role of information technology in facilitating this development. Our results show that transactive memory theory is an important theoretical lens for explaining mutual knowledge development in VPTs and virtual organizations.

Keywords: Mutual knowledge, shared understanding, transactive memory, virtual project teams, virtual teams, virtual project management.

1 INTRODUCTION

The use of distributed virtual project teams (VPTs) is increasingly prevalent in organizations today (Jarvenpaa and Leidner, 1999). VPTs have been described as teams whose members are separated by time and space and who have been brought together to accomplish a goal by conducting communication predominately through technology (Lipnack and Stamps, 1997). With the growing reliance on such globally dispersed teams it is vital for project managers to better understand how **communication** and **sharing** of knowledge can be facilitated. We have previously argued that shared understanding or common knowledge is primarily achieved via mutual knowledge and is a critical factor in stimulating effective virtual team interactions and ultimately better team performance (Davis and Khazanchi, 2007a).

In this paper we present the results from an empirical study that explores the following overarching research question: *how does mutual knowledge develop in a virtual project team*? Given that VPT members need to communicate, share knowledge, and locate and access each other's expertise, we address this research question by utilizing the theoretical lens of transactive memory systems. This notion is further elaborated in section 2. We also theorize that IT has a critical role to play in its development and communication. To further understanding this aspect, in this paper we also report on our investigation into the following question: *how does information technology (IT) play a role in the development and sharing of mutual knowledge*?

The research design presented in section 3 is followed by the results of this research in section 4. The final section presents a summary of our research and provides some ideas for future research.

2 BACKGROUND

2.1 Mutual Knowledge

Mutual knowledge is defined as "knowledge that communicating parties share and that each party knows that they both possess" or more simply put "knowing the same" (Davis and Khazanchi, 2007a). Previous research from Cramton (2001) suggests that mutual knowledge is necessary for group communication. Cramton (2001) reports several reasons for a failure in communication due to a breakdown in mutual knowledge. These breakdowns in mutual knowledge lead to a number of communication problems. For example, problems can include poor decision quality (Dennis, 1996) and extra time spent correcting failures of mutual knowledge (Krauss and Fussell, 1990). Additionally, research has suggested that it is the sharing of existing knowledge that leads to the creation of new knowledge (Chua, 2001). This suggestion further illustrates the importance of sharing knowledge in an effort to create mutual knowledge in VPTs.

It is our contention that mutual knowledge is a critical element in the achievement of shared understanding in VPTs and that effective mutual knowledge results in better virtual team performance. Prior research on virtual teams clearly supports this view in the sense that lack of common knowledge and shared understanding has been attributed to uneven information sharing among virtual team members (Hinds and Bailey, 2003).

2.2 Transactive Memory

We believe that transactive memory is a useful theoretical lens for understanding how mutual knowledge develops in VPTs becomes codified and used as shared knowledge. The notion of transactive memory systems was originally introduced by Wegner, Giuliano, and Hertel (1985) as the communication among a combination or grouping of individual minds. Specifically, the theory describes how small (Hollingshead, 1998; Wegner, 1986; Wegner et al., 1985) and large (Lewis, 2003; Wegner, 1995) groups can come together and develop complex "group minds" or memory systems

that can be potentially more effective than any of the single individuals that comprise the group (Wegner et al., 1985).

The theory of transactive memory is especially useful in explaining how individuals remember things. Simply put, transactive memory is "knowing who knows." The theory relies on the three stages of encoding, storage, and decoding or retrieval (Wegner, Giuliano, and Hertel, 1985; Wegner, 1986). For instance, in the encoding stage, group members discuss information, where it is going to be stored, and in what form it is going to be stored (Wegner, 1986). The storage phase is then concerned with clear and explicit instructions of who is going to be responsible for what information (Wegner, 1986). Finally, the retrieval stage is concerned with how team members find the previously stored information. Previous research has suggested that teams with a well developed transactive memory system have established similar labels and categories for encoding and retrieving information (Hollingshead, 1998). In operationalizing transactive memory we adopt the dimensions of 1) specialization (differences in team member's knowledge), 2) credibility (opinion of reliability of other team member's knowledge), and 3) coordination (effective knowledge processing) from Lewis (2003). Lewis (2003) used these dimensions to develop a Likert-type measurement scale for each phase of the transactive memory process in organizational settings and also validated the scale in three studies.

Previous research has linked transactive memory and mutual knowledge suggesting that transactive memory is a precursor to mutual knowledge in that transactive memory can influence the performance and satisfaction of a virtual team and that higher transactive memory could lead to higher mutual knowledge (Davis and Khazanchi, 2007b). For example, research from Yoo and Kanawattanachai (2001) has shown that organizational teams can improve performance, especially on complex tasks that require knowledge contributions from all team members, by relying on transactive memory systems. Additionally research on other types of teams has shown that teams that can **recognize** where expertise is needed and **located** tend to have greater perceived team performance (Faraj and Sproull, 2000; Rau, 2005). These conclusions provides strong evidence for our contention that mutual knowledge in VPTs will develop, get codified, receive credibility, and become accessible/utilized in the form of transactive memory systems.

3 RESEARCH DESIGN

Given the background in the previous section, we utilize the following research approach to studying our research questions.

3.1 Research Method

Survey research is considered to be an important experimental method used in information systems research (Kerlinger, 1986). In our study, we use a survey research design that includes both quantitative and qualitative questions. We chose this approach as opposed to doing nominal focus groups to collect qualitative process related data because of the convenience it offers in gathering the perspectives of global executives and team members who are geographically and temporally dispersed. Our main purpose was to measure the nature of transactive memory processes implicit in mutual knowledge associated with VPTs and the qualitative explanations of participants on how this was developed and utilized with the help of technology. To analyze the qualitative data we use the open coding technique from grounded theory research (Strauss and Corbin, 1998). Open coding is helpful in conceptualizing the responses to our descriptive survey questions through the process of naming and categorizing phenomena (Strauss and Corbin, 1998).

3.2 Survey Participants

The survey participants were a convenience sample obtained through corporate contacts. However as shown in Table 1 the respondents represented a variety of different virtual teams from different

organizations and industry sectors. A total of 27 individuals representing 10 industries responded to our survey at the time of reporting these results.

ID	Company Industry	Count
1	IT Services	6
2	Manufacturing	4
3	Finance	4
4	Aerospace/Engineering	4
5	Audit/Consulting	2
6	Services	2
7	Other	2
8	Transportation and Public Utilities	1
9	Telecommunications	1
10	Retail Trade	1
	Total	**27**

Table 1. Study Participants and Industries Represented

Additionally, the survey participants held various roles in their VPTs. Specifically participants included 11 project or program managers, five developer/programmer/software engineers, five domain experts, three business analysts, and three business managers. For the most part the participants had between 1 to 5 years work experience in virtual teams (18 participants) which exemplifies the increasing trend towards reliance on virtual teams in organizations today. Some of the other participants had 5 to 10 years experience working in virtual teams (7 participants) and one each had 10 to 15 years and 15 to 20 years of experience with virtual teams.

3.3 Instrumentation

To explore how mutual knowledge develops in a VPT setting, we asked respondents to think about their most recent experiences in a virtual team and/or virtual project. Additionally, we informed them of how we define both the terms virtual teams and mutual knowledge. Then we asked an open ended question that asked respondents to list three factors that they felt contributed to the development of mutual knowledge in their virtual team. To complement this open-ended question, we used a scale to assess “transactive memory” from Lewis (2003). These questions as adapted for our survey are shown in Figure 1.

Specialization 1. Each team member has specialized knowledge of some aspect of our project. 2. I have knowledge about an aspect of the project that no other team member has. 3. Different team members are responsible for expertise in different areas. 4. The specialized knowledge of several different team members was needed to complete the project deliverables. 5. I know which team members have expertise in specific areas. Credibility 1. I was comfortable accepting procedural suggestions from other team members. 2. I trusted that other members' knowledge about the project was credible. 3. I was confident relying on the information that other team members brought to the discussion. 4. When other members gave information, I wanted to double-check it for myself. (reversed) 5. I did not have much faith in other members' "expertise." (reversed) Coordination 1. Our team worked together in a well-coordinated fashion. 2. Our team had very few misunderstandings about what to do. 3. Our team needed to backtrack and start over a lot. (reversed) 4. We accomplished the task smoothly and efficiently. 5. There was much confusion about how we would accomplish the task. (reversed)
Note: 5-point disagree-agree, 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*.

Figure 1. Transactive Memory Dimensions Scale Items (Adapted from: Lewis, 2003)

The second research question in our study focused on how IT plays a role in the development of mutual knowledge. To address this question we asked participants to list three ways that IT has impacted the development of mutual knowledge in their virtual team experiences. We prefaced this question with a short definition of mutual knowledge. Additionally, multiple choice questions were asked regarding the proficiency of their virtual team members as well as the technologies that their team used in conducting virtual projects.

Finally, the survey instrument included demographic questions regarding the industry of the respondents' organization, their role in the virtual project, virtual team size, length of time working together in the team, geographical time differences, cultural differences, language differences, number of organizations represented, and overall virtual team experience in years[1].

4 RESULTS AND DISCUSSION

In this section, we begin by presenting the means on the questionnaire responses in relation to demographics and the types of projects represented by the survey participants.

As mentioned above, the demographic variables assessed in our survey included questions regarding the size of VPT, the length of time the VPT members had worked together, the time, culture, language, and personality differences among virtual team members, and the number of organizations represented by team members. These questions were modified from previous VPT research from Khazanchi and Zigurs (2005). Table 2 shows the results of these questions. As shown in the table, the projects represented in this study included a variety of team sizes with many teams including more than 15 team members working together for longer than a year. The teams worked with time differences from less than three hours difference to more than 10 hours difference. Additionally, the team members for the most part represented different cultures and languages with a mix of personalities. The teams were also comprised of members from a variety of organizations.

[1] The complete survey is available by request from the authors.

Demographic Variable for VPT	N	Frequency
Size of team	27	Less than 5 team members (14.8%) 5 to 10 team members (33.3%) 10 to 15 team members (11.1%) More than 15 team members (40.7%)
Length of time that your virtual team worked together	26	Less than 3 months (11.1%) 3 to 6 months (14.8%) 6 to 9 months (11.1%) 9 to 12 months (7.4%) More than 12 months (51.9%)
Greatest time difference between you and other virtual team members	26	Less than 3 hours (44.4%) Between 4 and 9 hours (14.8%) Greater than 10 hours (37.0%)
Cultural background of team members	27	Same culture (homogeneous) – (29.6%) Different culture (heterogeneous) – (40.7%) Different but team members had similar cultural traits or value systems (hybrid) (29.6%)
Language differences between team members	27	Same language (homogeneous) – (74.1%) Different languages—for example, U.S. and France (heterogeneous) – (11.1%) Same language, but no shared meaning—for example, U.S. and East Indian English (hybrid) – (14.8%)
Personality of majority of team members	27	Extremely homogeneous (same personalities) – (3.7%) A mixture of personality groups – (85.2%) Extremely heterogeneous (different personalities) – (11.1%)
Number of organizations or firms represented by your virtual team members	27	Team members represented a single organization (intra-organization) – (33.3%) Team members represented two different organizations – (22.2%) Team members represented more than two different organizations – (44.4%)

Table 2. Profile of Study Participants and their VPTs

The remainder of this section focuses on the development of mutual knowledge in the view of the study participants and discusses the how transactive memory theory explains mutual knowledge development. This is followed by a discussion of the role of IT in mutual knowledge development.

4.1 Development of Mutual Knowledge

Our primary research question is: *how does mutual knowledge develop in virtual project teams*? To explain the development of mutual knowledge in VPTs, we analyze how transactive memory systems expressed in terms of specialization, credibility, and coordination achieves this goal. The results include both the quantitative and qualitative open ended question, in which participants identified 71 unique items that influence the development of mutual knowledge.

Specialization: Our findings with respect to specialization or individual member expertise indicate that indeed virtual team members feel that team members bring with them specific knowledge to a team which is the information and knowledge that comprises a team's mutual knowledge. For example, team members made comments which suggest that virtual team members should include people with the right skill sets from different areas who are familiar with industry standards and have technology communication skills in order to develop mutual knowledge effectively. Table 3 presents some of these examples.

	Team Member Comments (Excerpts)
1	*Each member brings significant experience in certain areas so other team members need to know when and how to leverage the other team members experience. Don't expect every team member to know everything the other team members know.*
2	*All parties are familiar with the industries so called "language"*
3	*Hire self motivators and people that have the ability to self manage. This way they understand the types of questions they should and should not answer without the other team members involvement.*
4	*Clear understanding of roles and responsibilities*
5	*Understanding each team members personal style for communication, detail discovery, and presentation.*
6	*The right participants in the meetings - e.g. skills set.*
7	*Country specific practices and experience which are unique to the other part of the world - i.e. working cultures, communication cultures, etc.*

Table 3. Results from Open Ended Question Relating to Specialization

Additionally, our quantitative assessment of specialization confirms the conclusion that mutual knowledge develops through the leveraging of *individual member's specialized knowledge and the identifiable access to the members with such expertise* (refer Table 4).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Each team member has specialized knowledge of some aspect of our project.	0%	3.7%	11.1%	**70.4%**	14.8%	**3.96**
I have knowledge about an aspect of the project that no other team member has.	0%	29.6%	11.1%	**55.6%**	3.7%	**3.33**
Different team members are responsible for expertise in different areas.	0%	3.7%	0%	**63%**	33.3%	**4.26**
The specialized knowledge of several different team members was needed to complete the project deliverables.	3.7%	0%	11.1%	40.7%	**44.4%**	**4.22**
I know which team members have expertise in specific areas.	0%	0%	3.7%	**74.1%**	22.2%	**4.183**
Total Specialization Score						**3.99**

Table 4. Specialization

Credibility: The second stage of transactive memory based mutual knowledge development, credibility, is illustrated in the perception of VPT member's response that team members are credible and trustworthy and provide the team with information that helps establish mutual knowledge. For example, respondents made comments which suggested that credibility in terms of trust and the focus on a common goal were necessary for virtual teams to work together in developing mutual knowledge (refer Table 5 for some of these examples).

	Team Member Comments (Excerpts)
1	*High levels of trust, mutual respect and flexibility*
2	*We like each other, so it's easy to chat (have been on virtual teams where members weren't "friends" and communication wasn't as uninhibited)*
3	*Willingness to expend the effort to be ready and willing to share*
4	*Lack of alternative (e.g. we had to get a job done, no one else could/would do it)*
5	*Focus on a common goal and vision.*
6	*A clear agreement to no "hoarding of data/details" by any one member.*

Table 5. Results from Open Ended Question Relating to Credibility

The conclusion that mutual knowledge develops through transactive memory based specialization and requires the *establishment of trust and focus on a common goal* is further confirmed by the quantitative measure for credibility (refer Table 6).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
I was comfortable accepting procedural suggestions from other team members.	0%	3.7%	0%	**70.4%**	25.9%	**4.19**
I trusted that other members' knowledge about the project was credible.	0%	3.7%	0%	**74.1%**	22.2%	**4.15**
I was confident relying on the information that other team members brought to the discussion.	0%	0%	22.2%	**55.6%**	22.2%	**4.00**
When other members gave information, I wanted to double-check it for myself. (**reversed**)	0%	**51.9%**	29.6%	18.5%	0%	**2.67**
I did not have much faith in other members' "expertise." (**reversed**)	22.2%	**66.7%**	3.7%	7.4%	0%	**1.96**
Total Credibility Score						**3.94**

Table 6. Credibility

Coordination: Finally, the findings with respect to the third stage of transactive memory development, coordination, indicate that indeed virtual team members feel that teams work together smoothly with few misunderstandings or complications in terms of sharing mutual knowledge. For example, team members made comments suggesting that documentation standards and the proper storing of documentation is key in coordinating the work of team members and creating a knowledge base for the development of mutual knowledge. Participants also suggested that it is important for coordination in terms of teams making sure they are on the same page working towards the same goals and meeting regularly to ensure that things are running smoothly (refer Table 7 for some of these results).

	Team Member Comments (Excerpts)
1	*Reference material stored in a central repository*
2	*Regular status updates from groups that were posted publicly and accessible to all team members*
3	*Virtual room usage to provide visual display of topic or data to help bridge language challenges*
4	*Being copied via emails.*
5	*Tools to keep records*
6	*Enforced documentation standards.*
7	*Periodic conference calls to get confirmation that everyone's on the same page.*
8	*Occasional face-to-face reviews to validate and put 'names to faces'*
9	*Telecons with shared desktops so everyone is looking at the same data several times a week*
10	*Focusing on the high level with each other, not the detail.*

Table 7. Results from Open Ended Question Relating to Coordination

Table 8 summarizes the results for the items relating to coordination from Lewis (2003). Clearly, well coordinated teams are likely to process and use mutual knowledge.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Our team worked together in a well-coordinated fashion.	0%	11.5%	15.4%	**57.7%**	15.4%	**3.77**
Our team had very few misunderstandings about what to do.	0%	22.2%	29.6%	**40.7%**	7.4%	**3.33**
Our team needed to backtrack and start over a lot. (**reversed**)	11.1%	**70.4%**	14.8%	3.7%	0%	**2.11**
We accomplished the task smoothly and efficiently.	0%	11.1%	25.9%	**51.9%**	11.1%	**3.63**
There was much confusion about how we would accomplish the task. (**reversed**)	18.5%	**59.3%**	18.5%	3.7%	0%	**2.07**
Total Coordination Score						**3.71**

Table 8. Coordination

Overall, our analysis suggests that the transactive memory theory lens is an appropriate mechanism to understand the development of mutual knowledge within VPTs. The evidence supports our thesis that mutual knowledge develops and gets solidified through the transactive memory dimensions of specialization, credibility and coordination.

4.2 Role of IT in Mutual Knowledge Development

To understand the role of IT in developing and maintaining mutual knowledge from the viewpoint of the participants it is first necessary to understand what technologies participants use while working on virtual projects. Table 9 summarizes the information and communication technologies identified by the respondents. Most interesting in this list is the fact that all participants selected email, telephone, and conference calls as the dominant and commonly used technologies for virtual project work. In contrast, advanced collaboration tools such as simultaneous document editing and calendaring ended up being important but much lower in the preference list.

Technologies Used	Total
email	27
telephone	27
conference calling	27
voice mail	25
face-to-face meetings	21
instant messaging	21
video conferencing (room and/or desktop)	16
electronic meeting system (e.g., WebIQ, GroupSystems, Facilitate.com)	16
Web-based intranet tools (e.g., groove.net)	14
distributed project management tools	13
group calendaring	12
simultaneous document editing	11
fax	10
shared whiteboard	9
Other	5
workflow systems	2

Table 9. Available Technologies

Some of the "other" technologies mentioned in Table 9 include a shared network drive for documentation, shared databases (e.g., SharePoint portals), multi-site configuration management tools of documents, status reporting tools, and tools such as PDA/Cell Phones, SMS, and pagers. Additionally, participants described the proficiency of their virtual team members with virtual team technology in terms of those who are familiar with collaboration technologies (16, 59.3%) and those who are experts (11, 40.7%). No participant rated their team members as a novice user of collaboration technologies. Furthermore, participants were asked to rank the effectiveness of all tools they used for knowledge sharing. Table 10 summarizes these results sorted by the most frequently preferred to least frequently preferred technologies overall. Once again email, face-to-face, and phone seems to be the most frequently preferred tools.

Most Effective Technologies Used	Total
email	21
face-to-face meetings	20
conference calling	19
electronic meeting system (e.g., WebIQ, GroupSystems, Facilitate.com)	14
telephone	13
instant messaging	13
simultaneous document editing	8
video conferencing (room and/or desktop)	7
Web-based intranet tools (e.g., groove.net)	7
group calendaring	7
shared whiteboard	6
voice mail	4
distributed project management tools	4
workflow systems	4
Other	3
fax	2

Table 10. Effective Technology Options

Given the previous background, we now consider the results with regard to the second part of our research question. How does IT play a role in the development of mutual knowledge? In response to our open-ended question, overall, the participants identified 67 items regarding the role of technology

in the development of mutual knowledge. Using open coding techniques, an analysis of the data indicates that there are four IT categories that play a role in the development of mutual knowledge in a virtual project team setting.

1. Knowledge Communication Tools (Real-time and Asynchronous) - technologies for communication both real-time and asynchronous,
2. Knowledge Sharing Tools - technologies that offer centralized information storage,
3. Collaboration Tools - technologies that enable team members to work from anywhere and still be in tune with the team, and
4. Visual Presence Tools - and technologies that give the ability for team members to provide feedback to one another.

Knowledge Communication Tools (Real-time and Asynchronous): The first category that emerged, from 40 (nine items specifically relating to real-time communication) of the 67 items generated by the participants, covered tools that were found to be helpful by the study participants for developing mutual knowledge in terms of both real-time and asynchronous communication. For example, email and tools or technologies for chatting were mentioned. Additionally, technologies that offered real-time communication tools were mentioned for developing mutual knowledge with instant feedback to clear up any misunderstandings. Some excerpts of respondent comments are illustrated in Table 11.

	Team Member Comments
1	*E-mails: Keeps everyone on the same page as far as developments of the project. Quicker form of communication. Documented information. Can be instructions, requests, notices, etc. Makes people stand accountable for contributions.*
2	*Chatting is good for specific circumstances (e.g. where you won't need to reference the dialogue again) we were using Skype to decrease the phone bills, that was great because we could talk for hours for almost nothing. Company nixed Skype comms as too unsecure, so we're back to phones.*
3	*eMail / instant messaging allows communication of the written word in near real time which helps bridge language challenges*
4	*Instant message systems (IM) provide "hall way" conversation vehicles - although global time zones can make this less instantaneous.*
5	*Provision of 'real time' collaboration tools to facilitate audio conferencing, net meeting, virtual room linkage, and Sharepoint tools etc*

Table 11. Knowledge Communication Tools

Knowledge Sharing Tools: A second category of tools that emerged from 16 of the responses was focused on the means for sharing information and knowledge. Table 12 presents some examples that comment on this group of tools.

	Team Member Comments
1	*Shared Databases (SharePoint portals) have provided mutual access and simultaneous dissemination of information to all members of a global team.*
2	*Use of configuration management tools that allow for multiple site use, enables all teams to work from the same baseline. We use the Rational tools (ClearCase, ClearQuest).*
3	*Being able to link desktops has improved communication because you can share data and ensure everyone is looking at the same item.*
4	*Having a knowledge portal to exchange references and new information made information sharing much easier than attempting to share files via email or individually find references.*

Table 12. Results from Open Ended Question Relating to Knowledge Sharing Tools

Collaboration Tools: The third category that emerged from six of the generated items focuses on technologies that allow team members to work from anywhere and anytime. Table 14 lists excerpts from some of these comments.

	Team Member Comments
1	*Increased ability to work from home, out of town, etc.*
2	*Virtual meetings (like Netmeeting) allow people from a number of geographic locations to have a meeting together.*
3	*Subject matter experts availability to the team, when required (email/ conference calls/ etc.)*

Table 13. Results from Open Ended Question Relating to Collaboration Tools

Visual Presence Tools: Finally, the general idea of information technologies that offer feedback was mentioned by respondents in five cases as essential for the development of mutual knowledge. This category relates to the first in that feedback is a component or benefit of real-time communication. Refer Table 14 for some example comments relating to this category of tools.

	Team Member Comments
1	*Audio/visual technology lessens the distance of geography created by email and paper mail. It also has speeded up response time.*
2	*No facial express most of the time and could lead to misunderstanding*

Table 14. Results from Open Ended Question Relating to Visual Presence Tools

We can conclude from the previous analysis that IT has a critical role to play in the development of mutual knowledge in VPTs particularly with regard to establishing shared knowledge and communication. This conclusion is not surprising in that technology is the primary tool for communication among virtual team members (Jarvenpaa and Leidner, 1999). However, it is surprising that information processing tools and groupware tools did not specifically make an appearance in respondent discussions, despite being identified by a few participants as an effective VPT technology.

5 CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

This paper has presented an exploratory empirical study of how mutual knowledge develops in VPTs and the role of technology in hindering or facilitating this development. Our results provide initial evidence to support the contention that transactive memory theory is an important lens for explaining mutual knowledge development in VPTs and virtual organizations.

Our data shows that mutual knowledge develops and gets solidified through the transactive memory dimensions of specialization, credibility and coordination. Additionally, it appears that IT plays a critical role in the development of mutual knowledge in VPTs particularly the use of knowledge communication tools (real-time and asynchronous), knowledge sharing tools, collaboration tools, and visual presence tools. These conclusions are subject to the limitation of our research design, specifically with regard to the sample size and representativeness of our sample.

Future research needs to be conducted to verify our understanding of how transactive memory impacts the development and role of mutual knowledge in VPTs through field experiments. Another area of interest in this regard is to develop a better understanding of how mutual knowledge develops through the dimensions of transactive memory (specialization, credibility, and coordination) and impacts VPT performance. Finally, the development of mutual knowledge and its relationship with virtuality and its attributes such as team size and culture needs further exploration.

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