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KNOWLEDGE AND SKILLS ASSOCIATED WITH INFORMATION TECHNOLOGY: LEVELS AND INFLUENCES

*CONNAISSANCES ET COMPETENCES ASSOCIEES AUX TECHNOLOGIES
DE L'INFORMATION: NIVEAUX ET INFLUENCES*

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Abstract

In recent years, research on IT usage has increasingly focused on post-adoption usage, rather than initial acceptance of a technology regarded as new. Consistent with this recent trend, we seek to understand what factors influence employees' ongoing IT use and processes they rely on for expanding their knowledge and skills within organizational workgroups. Based on recommendations by Jaspersen, Carter and Zmud (2005), we seek to understand feature-level IT use of office software applications that are most frequently used within four workgroups. We first document the knowledge and skills of each employee at the feature level. Second, we analyze detailed, feature-level knowledge with a novel method based on Venn diagrams that reflects the degree to which coworkers have fully-, partially-, or non-overlapping knowledge and skills. Finally, we employ open-coding methods to identify enabling and inhibiting factors that shape the amount and effectiveness of IT-related knowledge transfer among coworkers. Our study yields surprising findings – including the fact that some employees have unique IT skills that do not overlap with their coworkers. Moreover, employees seek help from other workers who are at similar levels in the organizational hierarchy, and usually avoid seeking help from colleagues whose knowledge level is considerably higher, or whose knowledge base is radically different. Our results show that employees prefer to seek help from coworkers whose knowledge is similar to their own. We conclude by discussing the implication of our findings for managers and researchers.

Keywords: Post-adoption usage, knowledge workers, informal learning, social information processing

Résumé

Notre étude vise à comprendre les facteurs influençant l'utilisation des TI dans les groupes de travail. L'analyse porte sur l'utilisation des fonctionnalités des logiciels d'application. Elle révèle que les employés évitent de chercher de l'aide auprès de collègues qui leur semblent supérieurement qualifiés. Au contraire, ils vont solliciter ceux dont les niveaux de compétence leur semblent similaires.

Introduction

Research on IS adoption and acceptance is generally well developed on both theoretical and empirical levels (Barki et al 2007; Burton-Jones and Straub 2006). During the 1980s and 1990s, most research focused on understanding *initial* IT use and acceptance – factors that enable potential adopters to want to start using a new technology (Davis et al. 1989) – however, recent years have seen a call for new models of ongoing or post-adoption IT use, with the recent proliferation of new terms such as *extended* and *integrative* use (Saga and Zmud 1994), *deep usage* (Chin and Marcolin 2001), *loyal use* (Clay, Dennis and Ko 2005), *quality* of use (Boudreau and Seligman 2005), and *nature* of use (Jain and Kanungo 2005). The recent focus on post-adoption IT usage is driven by ongoing concerns that firms that invest heavily in IT may not be gaining optimal benefits from their spending (Brynjolfsson & Hitt 1998), coupled with the insight that organizations must upgrade the knowledge, skills and degree of worker empowerment to benefit from information technology investments (Bresnahan, Brynjolfsson and Hitt 2002).

Despite the advances of recent years, there are renewed calls for more research to further our understanding of post-adoption use specifically (Jasperson et al 2005) and the IT usage construct more generally (Barki et al 2007, Burton-Jones and Straub 2006). IT use is a multifaceted construct, which has often been conceptualized in terms of factors such as the amount of time spent using IT, as well as the diversity of and reliance on IT use (Trice and Treacy 1988). As was the case in other studies of post-adoption IT usage, we focus on individual-level IT usage among knowledge workers (Jasperson, et al., 1999; Spitler 2005).

Our study has three objectives. First, we assess the *actual* knowledge levels related to employees' familiarity with specific features of the two dominant software applications they use on a regular basis in their jobs. Second, we compare the specific skills of coworkers in order to gauge the degree of knowledge overlap. Knowledge overlap or "redundancy" (Nonaka 1990) has been shown to facilitate process innovation; moreover, it helps to establish a basis for whether employees will seek help from their coworkers when they need assistance using IT. Based on our analysis of pairs of coworkers, we classify employees as having either fully-, partially, or non-redundant knowledge. Third, using open-coding with qualitative interview data, we identify factors that facilitate and inhibit employees' interpersonal help-seeking behavior (Haggerty and Compeau 2001) associated with using IT on the job.

This study is part description and part theory generation, in which we use a combination of quantitative and qualitative research methods. With respect to these findings, we make no claims of generalizability beyond the workgroups and organizations that participated in our study. Below, we review the prior literature associated with our research questions, followed by a description of our methods, our results, and implications for managers and scholars.

Literature Review

Among many reasons given for the so-called *productivity paradox* (Brynjolfsson and Hitt 1998) are claims that organizations have not reengineered their business process to fully leverage the benefits of IT (Davenport 1992) and that employees use only a small fraction of the available software features (Adams 2006). For example, researchers have described scenarios where employees with limited skills in using a software package struggled to perform basic tasks or simply completed paper forms and then relied on coworkers to perform the transaction online (Boudreau 2003). While some authors blame poor user interface design, inadequate task/technology fit or insufficient hours spent in formal training, others note that formal training is not the panacea that some managers assume it to be (Gallivan, Spitler and Koufaris 2005). In recent years, there has been greater attention to post-adoption issues – such as providing post-adoption training (Ward & Bawden 1997), creating official help desks (Haggerty and Compeau 2001) or "competence centers" (Eriksen, Axline and Markus 1999) to assist users with problems, and more focus on informal communication (Kraut and Streeter 1995) and improvised learning (Boudreau and Robey 2005) for users.

Recently, IS researchers have argued that traditional models of IT adoption and diffusion are inadequate for various reasons. First, traditional models are better at explaining potential users' intentions to *try* a new technology (Davis et al 1992), rather than the likelihood of continuing to use a technology over time – or *how* they are likely to use it for performing specific tasks. In introducing a special issue on IT adoption, Chin and Marcolin (2001, p. 9) note that:

Zmud suggested that simple, voluntary and "shallow usage" diffusion models of the past should be expanded into complex, mandatory and "deep usage" diffusion models for the future. Echoing this perspective, we believe research into deep usage can begin by examining and integrating different forms of usage (e.g., the works of Munro, Huff, Marcolin & Compeau 1997 ... on user competence), the specific instrumental goals and the process that the usage behavior is meant to achieve, and constructs dealing with ... repeated usage over

time... Usage behavior that actually is meant to increase individual productivity will have to differ conceptually ... [from] simpler measures of whether an IT was used and the extent of its usage.

A second problem with traditional models of IT acceptance and use is that they are somewhat coarse in terms of how they represent the artifact that is used. Rather than assuming adoption of a system (i.e., a software application) as a whole, it may make more sense to specify what features are used, how adopters are using them, and for what purpose. This more detailed definition of IT use was illustrated in a recent study that proposed a three-part definition of IT use – as based on the user, the task, and the specific system being used (Burton-Jones and Straub 2006). Thus, a finer-grained understanding of what we mean by a “system” and how it is used (i.e., for what purpose) is needed to better understand IT usage. This view is advocated by Jaspersen, Carter and Zmud (2005), who observed that it is:

... very difficult to assess either the current state of the implementation effort or the effectiveness of past interventions without the availability of rich data reflecting users’ post-adoptive behaviors. We thus advocate that organizations strongly consider capturing users’ post-adoptive behaviors, over time, at a feature level of analysis (as well as outcomes associated with these behaviors). It is only through analyzing a community’s usage patterns at a level of detail sufficient to enable individual learning ... to be exposed, along with the outcomes associated with this learning, that the expectation gaps required to devise and direct interventions can themselves be exposed.

In recent years, IS researchers have made progress in studying IT usage at the level of specific features, rather than assuming that users accept or reject an entire system as a whole. Examples of studies that examined employees’ use of specific system features include Burton-Jones and Straub (2006) and Lippert and Forman (2005). This led to the recognition that, if users are competent at using just a small subset of system features, they may be unable to fully leverage its benefits (Adams 2006). At a basic level, it is important for researchers and managers to have a sense of what proportion of available features employees know how to use. This leads to our first research question:

Question 1: What proportion of available features do users know how to use, once the initial implementation process is complete and usage has reached an “equilibrium state” (Lassila and Brancheau 1999, Tyre and Orlikowski 1993)?

A related concern is how best to organize employees to coordinate their work so that organizations can achieve their goals effectively. Over the past century, different modes of industrial organization have been proposed. Since the era of Frederick Taylor, it was assumed that specialization and division-of-labor were keys to efficient and effective organizational performance (Davenport 1992); however, in recent decades, more attention has focused on employee empowerment – such as giving workers jobs with high levels of integration and identity – jobs in which employees can observe the value they provide to customers (Davenport and Nohria 1994). This new trend represents movement away from specialization to greater wholeness and integration within employees’ jobs. Yet this raises the question of what degree of overlap in skills and knowledge – labeled “knowledge redundancy” (Nonaka 1990) is most desirable for employees. If complete knowledge redundancy exists among employees, this has the benefit of making employees interchangeable, although it also represents needless duplication of skills. Conversely, if skills overlap is nonexistent or minimal, it may be difficult for workers to communicate and coordinate effectively with each other. These issues have been investigated in the context of firm performance and innovation in Japanese firms, where Nonaka (1990) showed that high levels of knowledge redundancy among workers are desirable. He notes that “redundancy refers to a condition where some types of excess information [exist] ... in addition to the minimal amount of requisite information held by every individual ... in performing a specific function... When information is redundant it becomes possible for one to enter the territory or specialty of another... [Employee] interaction where information is redundant facilitates the transfer of tacit knowledge among team members. Since members share overlapping information, they can sense what others are trying to articulate” (Nonaka 1990, p. 28, 33).

The question of the ideal level of redundancy of IT-related knowledge and skills among employees within a given workgroup or organization has not been addressed, to our knowledge. However, recent studies of user-developer interaction have argued that human resource management techniques such as job rotation are desirable to develop knowledge redundancy and social capital among IT professionals and users (Bensaou and Earl 1998; Reich and Kaarst-Brown 1999). While these studies were limited to techniques to increase common knowledge between users and IT employees, we believe the issue of knowledge overlap among employees, in general, is worthy of attention. This leads to our second research question:

Question 2: What is the degree of knowledge redundancy or overlap among coworkers – in terms of the proportion of common vs. unique knowledge associated with using IT?

To the extent that different employees have different levels of knowledge related to the systems they use to perform their work, we would expect them to engage in various processes to learn the necessary skills. Over the past decade,

many studies have focused on how employees actually use IT in performing their jobs. Based on qualitative studies, for example, we have learned that employees *evolve* in terms of their IT use over time (Orlikowski 1996) – sometimes *improvising* solutions that help them perform their job (Orlikowski and Hofman 1997), and *enacting* new patterns of feature usage (Orlikowski 2000) as well as new ways of collaborating and coordinating with coworkers. While we know that organizational processes and technologies must mutually adapt over time (Leonard-Barton 1988) to derive optimal benefits, only recently has there been focused research on how employees' knowledge and skills change over time. Such growth in employees' IT-related knowledge can take a host of forms – including top-down managerial interventions, such as ongoing training classes, help desks (Haggerty and Compeau 2001) and “competence centers” (Eriksen, Axline and Markus 1999) that employ technical support specialists, and also informal mechanisms like self-discovery learning (Lim et al 1997) and help-seeking and help-giving among employees (Spitler 2005). This leads to our third research question:

Question 3: What factors facilitate or inhibit employees in learning from their coworkers?

Methodology

Research Design

This study is part description and part theory generation. The first two questions examine subjects' knowledge levels and the level of knowledge redundancy among coworkers' skills, while the third research question seeks to identify factors that may influence learning processes among coworkers. In describing these factors, we hope to provide managers with recommendations for supporting knowledge sharing. Since knowledge sharing is subject to many contextual and temporal influences, we chose to examine them in a natural setting. This calls for use of more “engaged” research methods (Nandhakumar and Jones 1997), specifically case studies (Eisenhardt 1989; Yin 1994).

Sampling

The setting involves employees' use of desktop applications such as word processing, spreadsheets, database, email, presentation and web authoring software. It has been estimated that there are over 300 million desktop application users worldwide (ZDNet 2002), which would rank this group as the fourth most populous nation. Moreover, such knowledge workers spend a great deal of time using desktop applications for a range of tasks (George et al. 1995). While knowledge workers can be found in manufacturing firms, service firms typically have proportionately more knowledge workers, so we focused on service sector firms in our field study.

The first author examined a total of 21 employees from four workgroups located in three service firms – all in different industries. We selected workgroups with the objective of obtaining variety in task context at the workgroup level, because we wanted to ensure that our findings would hold across different task contexts. The first two workgroups were located in the same financial services organization: workgroup A develops and maintains the firm's intranet content, and workgroup B provides routine and ad hoc reporting services to internal clients. From a second firm in the health insurance industry, we studied workgroup C, which creates and maintains process documentation related to internal procedures that are published on company's intranet. The last workgroup, group D, was drawn from the life insurance industry, and this group files securities prospectus on the SEC's Edgar system for its clients. All firms are located in the same large city in the northeastern U.S. Details of each workgroup are summarized Table 1.

Data Collection

Since we sought to identify facilitating and inhibiting factors associated with learning IT skills, based on subjects' beliefs and actual behavior, we employed multiple data collection methods in order to triangulate on the evidence (Eisenhardt 1989). Specifically, we employed ethnographic methods, including interviews and passive observation, in addition to survey methods. The first author collected data in the following sequence: (1) structured interviews with each employee, (2) direct passive observation of employees, (3) semi-structured interviews with each employee, and (4) completion of a brief survey. All interviews were conducted with each employee individually and lasted 60-90 minutes each. Structured interviews followed a specific protocol, were tape recorded and transcribed. The questions sought background information about the employee's work experience, self-reported skill levels and a description of the desktop software applications they used.

Table 1: Workgroup Profiles

Workgroup	Industry	Primary Task	Dominant Programs	
A	Financial Services	Develop and maintain Intranet content	Word processing	Presentation
B	Financial Services	Provide routine and ad hoc reporting services	Spreadsheet	Database
C	Health Insurance	Create and maintain internal workflow documentation	Word processing	Web Authoring
D	Life Insurance	Securities prospectus filing	Word processing	Spreadsheet

The semi-structured interview (which was conducted after observing employees) had the goal of clarifying, elaborating on and probing some details identified during observation.¹ At the end of the semi-structured interview, each subject was requested to complete a “command tally sheet” which listed all possible (second-level) menu commands from the two desktop applications that were used most frequently by employees in that workgroup. As shown in Table 1, we refer to these as the “dominant programs” for each workgroup. Respondents were requested to return the completed “command tally sheet” directly to the first author, and all subjects did so within two weeks. In total, the first author spent 6-7 days collecting data from each workgroup.

Passive observation data were coded and summarized in tabular layouts following principles advocated by Miles and Huberman (1994). Lasting 4-5 days for each workgroup, observation focused on employees’ interactions with their coworkers. These interactions were analyzed based on the content and nature of verbal and non-verbal communication that occurred between two or more co-located coworkers. Employees’ interactions were coded as being related to one of the following four activities: (i) a work task, (ii) a management or administrative issue, (iii) a social or personal exchange, and (iv) technology learning. Each interaction among coworkers was recorded in terms of duration, and classified in terms of one or more of the above activities. Most interactions involved two coworkers; however, a few involved three coworkers. In some cases, the content and nature of the interaction could not be discerned, usually when two or more interactions occurred simultaneously, such that it was impossible to document the concurrent interaction episodes. Total observation time across all four workgroups was just over 82 hours.

When an interaction involved knowledge sharing – which we label as a *learning episode* – the first author recorded detailed information about the application and features in question, the subjects involved, a contextual description of what else was occurring, as well as date and time details. This information was used to stimulate subjects’ recall during the subsequent semi-structured interviews. In the interviews (which usually occurred a few days later) subjects were asked to reflect on *why* the learning episode led to a favorable or unfavorable outcomes.

Each subject completed one command tally sheet for each dominant program. This document featured screen-shots of the application’s second-level menu commands.² Subjects were asked to place a checkmark by each command that they knew. To “know” a command was defined as “... hav[ing] the ability to describe the command’s purpose or effect, and to articulate its usefulness by reciting one practical example.” This definition is intended to capture employees’ understanding of the commands’ meaning—a level corresponding to Shneiderman’s (1983) *semantic* knowledge. In addition to helping us triangulate data from the interviews, the command tally sheet support feature-level analyses that provide a detailed understanding of workers’ skills (Jasperson et al 2005).

For each workgroup, we identified two dominant programs according to subjects’ responses to the question, “What programs do you use at least some of the time at work?” Subjects consistently identified dominant programs at the workgroup level, which we confirmed during observation. The amount of time each application was used varied across workgroups, due to task requirements. For instance, workgroup A showed used word processing extensively to maintain the firm’s intranet content, while workgroup B relied on spreadsheets to provide a flexible platform that met its reporting requirements, while providing compatibility with various data sources.

¹ Interview protocols may be obtained from the first author.

² Screen-shots included all second-level commands in the dominant programs. For instance, in MS Word,® the second-level commands under FILE include NEW, OPEN, CLOSE, SAVE, SAVE AS, PRINT, PROPERTIES, etc.

Data Analysis

Question 1. Based on the command tally sheet, we counted the number of commands that each subject knew in the two dominant programs. Given that we have full data for 21 subjects, this yields a total of 42 data points. We consider these data to be an objective measure of subjects' knowledge levels, which we use to answer question 1.

Question 2. The command tallies provided a basis to compare subjects' knowledge. While many comparisons are possible, we chose to compare subjects' knowledge of specific features in the dominant applications to knowledge possessed by their coworkers. We illustrate our data analysis approach in several vignettes, as illustrated in Figures 1.1-1.3. These figures show how each pair of coworkers "ticked" specific File menu commands on the command tally sheet. Figure 1.1 shows that Chris indicated knowledge of the Page Setup and Print commands, while Jamie indicated knowledge of the Print Preview command. In the lower part of the figure, the Venn diagram shows two non-overlapping circles, since there was no command that both Chris and Jamie knew. We characterize Chris' and Jamie's IT knowledge related to MS Word's File menu as "non-overlapping." Figures 1.2 and 1.3 show patterns of partial overlap and full overlap, with the corresponding Venn diagrams representing these patterns, respectively.

On a conceptual level the Venn diagrams suggest three possible results for each pair of coworkers: non-overlapping, partial-overlapping, and full-overlapping. We performed pairwise comparisons for all coworker dyads. These pairwise comparisons were generally *not* symmetrical, so they yield two data points for each pair of coworkers. The reason is because the skills of employee Y may fully overlap those of employee Z, but not vice-versa. We computed the number of possible pairwise comparisons per workgroup as $n \times (n-1)$, where n is the number of group members. Since workgroups A, B, C and D have 6, 6, 5 and 4 members, respectively, there were 92 pairwise comparisons. Since we analyzed knowledge overlap for *two* dominant programs per group, we have a total of 184 data points.

Question 3. The first author recorded 26 learning episodes, based on the observational data, and then subsequently discussed and recorded these episodes as part of the semi-structured interviews. Using open coding techniques (Glaser and Straus 1967), he reviewed all interview transcripts, searching for themes that suggested similar, consistent or systematic influences that enabled or inhibited interaction among coworkers. Several themes were identified, based on related comments from various subjects. We coded each theme as either a facilitating factor (if the attributes corresponding to this theme support, encourage or promote interaction among coworkers) or as an inhibiting factor (if the attributes served to discouraged interaction among coworkers).

Results

Question 1 – What are knowledge workers' actual knowledge levels?

Using command tally counts, subjects' self-reported knowledge levels for the two dominant programs averaged 62% with a standard deviation of 26%. These data indicate that, on average, subjects knew how to use roughly two-thirds of the commands available in the dominant programs, but that subjects' knowledge levels varied greatly.

Question 2 – How do knowledge workers' knowledge compositions compare?

Figure 2.1 shows actual knowledge comparisons for one member of workgroup C (Cecelia). Specifically, we see that Cecelia's knowledge of word processing is a subset of Cindy's word processing knowledge; hence we say that Cindy's knowledge fully overlaps that of Cecelia (since the circle indicating Cecelia's knowledge is fully enclosed within the circle representing Cindy's knowledge). Figure 2.1 shows "Area A" indicating that Cecelia has no word processing knowledge that is not *also* possessed by Cindy. This also implies that Cecelia has no word processing knowledge that may benefit Cindy. Conversely, part of Cindy's circle lies outside of Cecelia's circle, which means that Cindy has word processing knowledge that may benefit Cecelia (specifically, the 28% labeled "Area B").

Cecelia's knowledge composition partially overlaps with her remaining coworkers. The circle representing Cecelia's knowledge exists partly outside of the circles that reflect other coworkers' word processing knowledge. For instance, while 78% of Cecelia's knowledge is also known by Curt (Area A), 22% of her knowledge is *not* known by Curt (Area C). This means that Cecelia has word processing knowledge that may benefit Curt, if Curt is willing to acquire this knowledge from Cecelia, and if she can transfer that knowledge to him. Because Curt's circle lies partly beyond Cecelia's circle, as well, this means that Curt has some knowledge that is not known by Cecelia (specifically, the 27% in Area B), which may benefit Cecelia, if Curt can transfer that knowledge to her, and if she is willing to engage in learning it. Due to these patterns of partial overlap, we define Cecelia and Curt as being in a "mutually beneficial relationship" – in terms of the potential learning gains that each may achieve from the other.

In most cases, partial overlap is asymmetric in nature. This asymmetry is most evident for Cecelia and Carol as indicated by the values of 8% and 28% non-overlapping knowledge in Figure 2.1. This figure shows that 8% of Cecelia's word processing knowledge is not also known by Carol; conversely, 28% of Carol's word processing knowledge is not also known by Cecelia. Thus, it is possible for Cecelia and Carol to each transfer some word processing knowledge to each other. The nature of the asymmetry suggests that the potential knowledge transfer benefit is greater with regard to Carol transferring specific knowledge to Cecelia, rather than vice-versa.

In total, we analyzed 184 comparisons of pairwise knowledge compositions across the four workgroups. We found that 158 (86%) of the comparisons reflected partially overlapping knowledge. Among these, the average level of unshared knowledge was 25% (so, on average, 25% of employees' IT knowledge of the dominant programs was *not* known by their coworkers). This suggests the potential for employees to transfer IT-related knowledge to coworkers.

On the other hand, the data reveal that, in cases where knowledge partially overlaps, the average level of shared knowledge was 75%. This means that coworkers shared a common knowledge base, which allows them to have some reference point for the knowledge possessed by their peers. This shared knowledge is a necessary condition for employees to collaborate in using IT in their work, since shared knowledge enhances employees' ability to achieve common goals (Hansen 1999; Nelson and Coopridge 1996). Shared knowledge also allows employees to innovate in ways that may benefit the organization (Nonaka 1990). Shared knowledge can facilitate the transfer of additional knowledge and skills between employees, and also enhance performance at the workgroup or organizational level.

We characterized just eight of the 184 pairwise comparisons (4%) as non-overlapping knowledge, and 18 (10%) as fully-overlapping knowledge. The former examples (non-overlapping knowledge) all occurred in workgroup C, and based on a single employee whose pairwise comparisons with his coworkers revealed total non-overlap for a web authoring program. Pairwise comparisons with four coworkers yielded eight dyadic comparisons.³ While there were *relatively* few instances of full overlap (just 10%) among the 184 comparisons, full overlap still has the potential for some learning, specifically, for the less knowledgeable employee in each dyad. Full overlap scenarios are not symmetric; hence an employee whose knowledge is a subset of a coworker's knowledge, can learn from that coworker.

Question 3 – What are facilitating and inhibiting factors influence coworkers' interactions processes?

During approximately 82 hours of observation across all four workgroups, we identified a total of 473 interactions among coworkers. These interactions lasted 3.9 minutes, on average, and the nature and content of these interactions were discernible in 453 cases (96%). Table 2 shows the relative proportion of activities represented by these interactions. These figures sum to over 100% because we coded some interactions as representing more than one activity.

Table 2: Summary of Interaction Categories

Occurrences		Interaction Characteristic
280	62%	(i) related to a work task
51	11%	(ii) related to a management or administrative issue
146	32%	(iii) related to a social or personal exchange
26	6%	(iv) related to technology learning.
453		Total

Most interactions coworkers were associated with a work task (62%), with an additional 32% related to a social or personal exchange. A relatively small share of interactions concerned management issues, and just 26 interactions (6%) were associated with IT learning. While we consider it surprising that the latter value was not larger, it may suggest that coworkers have little *need* to share information about IT. Moreover, since subjects' knowledge levels were reasonably high, on average (as shown by the mean value of respondents knowing 62% of commands for the dominant programs), then there may not have been a high need for subjects to seek help from coworkers. Despite the fact that, on average, subjects did not know 38% of the dominant program commands, it is also likely that they did

³ We followed up to remind the subject that some commands are common across Microsoft applications, e.g., FILE | NEW, FILE | PRINT. Since he had indicated knowledge of these commands in another dominant program, it was clear that he knew some of these commands. He nonetheless insisted he had no knowledge of the commands. One interpretation is that he wanted to avoid any claim to knowledge of the application – a response we believe was more political than rational.

not necessarily need to use the latter (unknown) features; hence, this may explain why we observed relatively few episodes of knowledge-seeking and knowledge-transfer associated with IT usage.

Table 3 shows that, of these 26 learning episodes, ten were related to technology learning *only*, while 21 reflected technology learning combined with some other activity (e.g., a work task, management issue, or social exchange). In 58% of the observed learning episodes, subjects exchanged information about both a technology feature *and* a task. This is consistent with prior explanations that describe technology learning as occurring in the context of performing routine work (Lave and Wenger 1991; Spitler 2005). As described in our methods section, the final semi-structured interviews asked subjects to reflect upon and provide additional details about these learning episodes that we observed. Based on subjects' responses to the semi-structured interviews, we used open coding to identify themes associated with the learning episodes. These themes suggest systematic influences that affect coworker interactions to the extent that they recurred across many subjects. Below, we describe six themes that emerged from qualitative analysis of the passive observation, complemented by the semi-structured interviews.

Table 3: Distribution of Technology Learning Episodes

Occurrences		Interaction Characteristic
15	58%	(i) & (iv)
2	8%	(ii) & (iv)
4	15%	(iii) & (iv)
10	38%	(iv) only
26		Total

Theme 1: Role Differentiation. In any organization, roles exist within a hierarchy. Hierarchies provide for roles that are differentiated with respect to both *horizontal* and *vertical* dimensions (Rice and Aydin 1991). Horizontal differentiation relates to functional task differences. Two roles have greater horizontal differentiation when the respective task domains are more dissimilar; conversely, less horizontal differentiation occurs when roles are alike. On the other hand, the *vertical* dimension of role differentiation relates to the hierarchical level within the firm. Two job roles are vertically differentiated by the number of hierarchical reporting levels between them.

We found that both vertical and horizontal role differentiation influence subjects' inclination to engage coworkers in interaction processes for peer learning. For instance, the following comments suggest that more vertical differentiation inhibits interaction among coworkers; conversely less vertical differentiation facilitates interaction:

"... it's not the fact that I didn't want to correct her [on a better way to do something in the program], but I'm less likely to because she is the boss ..."

"... I would go to ... the support people before I would go to management for software advice or as a resource",

"Just in general, if I have a question [about a program], I'm more likely to go to somebody I perceive as a peer rather than somebody I perceive as a supervisor. "

Similarly, the following quotes suggest that less horizontal differentiation promotes interaction among coworkers:

"[Our] roles are more closely related [...so] I would be more inclined to go to her [for assistance].", and

"If they were both free, I would be more likely go to [name of coworker] only because I've done more [work] with her ... than I have with"

Others researchers have studied the effect of horizontal differentiation on social interaction processes. For instance, Cross et al (2001) found that task interdependence (the degree to which an employee's task depends on a coworker) had a strong, consistent effect on employees' decisions regarding which people to ask for help.

Theme 2: Knowledge Disparity. We know that, in general, employees vary in terms of their knowledge associated with desktop applications (as well as the specific knowledge content). This was true for our subjects, as well, as shown in the results above. Thus, we know that knowledge differences among pairs of coworkers can result from either differences in knowledge level (i.e., more or less knowledge) or differences in specific knowledge content (i.e., specific features). We refer to differences in knowledge states as "knowledge disparity," which can range from

low to high along a continuum. Figure 3.1 illustrates our notion of knowledge disparity. For instance, the disparity between the knowledge of employees A and B is less than the knowledge disparity between employees B and D. Of the various pairwise comparisons illustrated in Figure 3.1, it is clear that the knowledge disparity between subjects B and D is much greater than that the disparity between A–B or C–D. Moreover, the size of the knowledge disparities of A-B and C-D are approximately equal.

Based on our qualitative analysis of learning episodes, it appears that lower levels of knowledge disparity between coworkers promote help-seeking; conversely, higher levels of knowledge disparity inhibits help-seeking and other forms of interaction. The following quotes from subjects describe scenarios where knowledge disparity inhibited interaction between coworkers – since subjects avoided asking specific colleagues for help, or when they did ask for help, they kept the interaction brief, or terminated the exchange prematurely. These results are reported as sets of interview dialogs between the first author, as observer (O), and the interview subject (S).

O: ...[the co-worker] said to [you], “And then you have to synchronize the files.” And ... you kind of go, “OK.” ... Did you know what synchronize meant?

S: ... So maybe I didn't.

O: Was that associated at all with the dropping off of your interest?

S: Probably.

O: ... when he said [cache] to you, you said, “What?” like that.

S: I had no idea what the term meant....

O: ...if more technical terms had started coming out can you give me an idea of how you might react to that? ...

S: I would say if anything [with] frustration.

These examples show that differences in knowledge of technical jargon interfered with coworkers communication. While the reason for such interference is obvious at face value (coworkers do not speak the same language), these examples nevertheless illustrate the concept of knowledge disparity, which emerged in various ways.

Therefore, we argue that knowledge disparity has an inhibiting effect on coworker interaction, even to the extent that it prevents an employee from seeking knowledge from a coworker who may know much more about a given application. Referring back to Figure 3.1, we argue that employee B may be more inclined to seek help from employee A rather than from C or D. This may, at first glance, seem counterintuitive, because C or D have higher knowledge levels than B; however this paradox may be explained by the fact that B may feel less intimidated asking questions to A, relative to C or D. Thus, the level of knowledge disparity has an adverse effect on help-seeking behavior. In short, employees are reluctant to turn to those who know a great deal more than they do.

This result is somewhat surprising, because it contradicts research on knowledge management: specifically, studies of source credibility have consistently shown that employees seek help from experts (Ko et al 2005). However, we believe that employee A's inclination to seek help from B (rather than C or D) makes sense, in terms of our notion of knowledge disparity. This interpretation is also consistent with a study by Schilling et al (2003), who found that two individuals of *modest* difference in levels of experience benefited more from learning outcomes, compared to pairs of individuals marked by *large* differences in experience. Likewise, Swap et al (2001) suggest that a coworker whose knowledge level is close to that of a given employee may be a better teacher because the knowledge gap is minimal. High levels of knowledge disparity apparently reduce potential learners' willingness to ask another person for help; or conversely, the disparity reduces the potential teacher's belief in the learner's ability to grasp the new knowledge. These results are consistent with prior results showing that "... people with less general and application-specific expertise preferred known individuals who may better understand the user's work context ... than the more impersonal and formal positions, which may ... represent more technical knowledge" (Rice et al. 1999, p. 301).

At the level of interorganizational alliances, Zahra and George (2002) note that *knowledge complementary* between two firms is related to a firm's absorptive capacity. Defining knowledge complementarity as the extent to which knowledge is related to and yet different from the knowledge of others (Lofstrom 2000), their studies show that for firms to benefit from interorganizational alliances, the knowledge of the “teacher” firm should not be grossly different from that of the “student” firm – otherwise problems may occur in achieving the goals of the alliance.

Theme 3: Time Availability. In our study, time availability relates to one's perception of a coworker having time to help other employees. Time availability may take the form of slack time – which includes periods when an employee has no work to do. Slack time may be intentionally or unintentionally designed into a job. An employee's perception of a coworker's level of control over the pace of their work may also affect their beliefs about the

coworker's availability to offer help. We found several comments that reflected employees' beliefs about a coworker's time availability which, in turn, influenced whether they sought help from the coworker. When an employee perceived a coworker as having less time availability, he or she was less likely to engage that coworker with questions.

"...it's tough [for someone] in her position, because she is someone who is extremely busy. [I can] use other people [...] on the team who have a little more time...", and

"Because [they are] working on other things or they're busy. I just don't want to ask them tedious questions."

"We were in a rush and I didn't want to bother [...] with [an explanation.... I needed to think about [the feedback] and respond in a pretty timely manner...."

Theme 4: Spatial Proximity. Spatial proximity deals with how physically close employees are to coworkers (Rice and Aydin 1991). Subjects indicated that the ease of interacting with nearby coworkers influenced their tendency to ask them for help. The following comments suggest that spatial proximity promotes interaction among coworkers:

"[The person] sits on the other side of me ... so probably a matter of convenience. ... easier to poke my head over ... or holler over",

"... whereas [they] are easily accessible. They're within earshot ... right there. I don't have to get out of my chair.", and

"I'd probably go to [name of coworker] mostly because they're closer."

The effect of spatial proximity on interaction is well-known (Zahn 1991, Monge et al 1985). For instance proximity is known to reduce the effort required to interact with coworkers, thereby increasing the opportunities for frequent social interaction. Proximity may also have an indirect role. For instance, Borgatti and Cross (2003) found that how much employees knew about what their coworkers knew (i.e., the level of transactive memory) mediated the relationship between proximity and information seeking behavior. In short, proximity raises an individual's familiarity with coworkers' knowledge which, in turn, enhances an employee's information-seeking behavior.

Theme 5: Familiarity. Familiarity relates to the extent to which coworkers know each other. While this construct may be influenced by spatial proximity or the longevity of workgroup membership, it is also affected by personality and other social factors. For example, some members never become fully socialized into a workgroup. In particular, we found that familiarity enhanced subjects' tendency to ask coworkers for help related to technology learning.

"I think I could probably ask [the person] a question if I had one, but I've had so few conversations with [the person] about anything that it would just seem a little bit awkward.", and

"I don't know [the person] that well so [it's unlikely that I'd go ... for help]."

Related to our notion of familiarity, Cross et al (2001) discussed friendship as significantly related to individuals' decisions regarding who to ask for help. People perceived as friends were more likely to be sought out than others.

Theme 6: Passive Initiator. The notion of "passive initiator" relates to the potential reluctance of employees who have knowledge to share it with others, in the absence of a specific request. We illustrate the concept in Figure 3.2. This figure shows two coworkers A and B, where B has some knowledge that is *not* held by A. These coworkers may engage in interactions such that A occupies the *initiator* role (e.g., A starts by asking B a specific question). In the *receiver* role, B replies by answering A's question. By answering the question, B transfers some knowledge to A – presumably new knowledge, which was not previously known by A. The result is that learning occurs.

Figure 3.2 also shows a different interaction sequence (which we label an *active initiator* scenario), with A and B now playing opposite roles. In this scenario, B initiates the interaction by telling A that he should consider using a different software feature (one previously unknown to A) which, in B's opinion, is better for performing a given task. A may respond with by thanking B, or by asking additional questions for clarification. Learning occurs in this scenario as well, but we believe that this scenario (active initiator) is much less common than the former (passive initiator). It is more rare because a person who has potential knowledge to share with coworkers is generally passive – meaning that they don't actively force their knowledge on coworkers, unless a coworker specifically asks for help. Subjects identified various scenarios that illustrated the tendency of the person who knows more to play the "passive initiator" role and, by comparison, the paucity of active initiator scenarios.

"I would not interrupt somebody to say, 'Oh, by the way, there's another way you can do that.'"

“I don’t know whether it’s my place [to suggest a better way] or not.”,

“Typically it wouldn’t occur to me, I don’t think to just kind of offer [my knowledge] ‘out of the blue,’ ...”, and

“I don’t like to insult anybody as to the way they’ve done something...”.

For instance, Rice et al (1999) suggested that researchers should consider the value of both help-seeking (i.e., passive initiator) and help-giving (i.e., active initiator) relationships. As one way to increase learning, converting individuals who are passive initiators into active initiators might facilitate more knowledge transfer. However, such behavior may also be regarded as “pushy” or acting as a “know it all.” Nevertheless, transforming from a passive initiator scenario to an active initiator scenario may result in more knowledge sharing among workgroup members.

In summary, we identified six themes that represent facilitating and inhibiting factors, which influence coworker interaction processes associated with technology learning. In short, we believe that the volume of learning episodes will become more common as the number and level of facilitating factors increases, and conversely, that learning episodes will become less common as inhibiting factors increase. Table 4 summarizes the six factors.

Table 4: Framework Summarizing Themes that Facilitate and Inhibit Interaction

Facilitating Factors	Effect on interaction processes
Time Availability (+)	Greater time availability facilitates interaction processes
Spatial Proximity (+)	Greater spatial proximity facilitates interaction processes
Familiarity (+)	Greater levels of familiarity facilitate interaction processes
Passive to Active Initiator (+)	Passive to active initiator role conversion facilitates interaction processes
Inhibiting Factors	Effect on interaction processes
Role Differentiation (-)	Greater vertical and horizontal role differentiation inhibits interaction processes
Knowledge Disparity (-)	Greater levels of knowledge disparity inhibit interaction processes

Discussion and Conclusions

Our results suggests a range of facilitating and inhibiting factors that affect coworkers’ interaction processes for informal technology learning. We identified six facilitating and inhibiting factors through our qualitative field study. One notable extension to our study would be to replicate this study in different usage contexts, in order to determine whether the types of interaction processes we observed also occur among employees who differ in terms of their professional experience, job type, age, industry, and other factors (George et al. 1995). Another extension would be to formulate and test specific propositions, based on our insights above, using survey methods. Based on our study, we believe that practitioners can take various steps to create a more optimal learning context for employees. The improvised nature of informal learning suggests that much learning results from spontaneous interactions in the course of performing routine work (Lave and Wenger 1991). Not only does this suggest that formal training is not the most effective method for learning to use technology (Gallivan, Spitler and Koufaris 1995), but it also shows that deliberate management efforts to harness informal learning may be infeasible at worst and elusive at best.

The literature on communities of practice (e.g., Wenger and Synder 2000) suggest that, while managers cannot mandate learning communities, they can create conditions favorable for creation and evolution of such communities. Specifically, Wenger and Snyder specify three conditions that facilitate communities of practice that may yield maximum benefit: such communities need to have the right mix of people, supportive infrastructures, and some processes of measuring value. Likewise, Jasperson et al (2005) note that managers’ attention often ceases after initial IT adoption; thus, they advise managers to prolong their *active* attention and guidance throughout the post-adoption period. Specifically, they underscore the value of periodic interventions – which they label *substantive* technology use – to promote ongoing learning, post-adoption. Similarly, Vidgen et al (1993, p. 107) argue that learning requires “a continuous cycle of *purposeful* action ...” if the quality of employees’ IT use is to achieve optimal levels in the long run. Without such purposeful action, employees may stagnate at very low levels of IT knowledge and skills – as indicated by the *non-users* and *limited users* in Boudreau’s (2003) study of employees

who failed to leverage most capabilities of their ERP system. We conclude that there are a variety of ways that managers may directly and indirectly provide a context that encourages informal learning.

Our analysis of knowledge in coworker dyads showed a preponderance of asymmetric, partial overlap among coworkers. This suggests that most employees have some non-redundant knowledge with their colleagues, and that they have sufficient share knowledge to potentially serve as teachers for each other. This calls into question previous conceptions of the “lead user” role (Lee 1986, Nelson and Cheney 1987), in which the lead users is assumed to be a single, specific employee within a department or company who offers help and trouble-shoots for coworkers. The literature has treated the lead user concept as a role to be filled by one person per workgroup (Ko et al 2005; Spitler 2005; Winter et al 1997; Sein et al 1987). As an organizing principle for knowledge sharing, this conceptual of the lead user may overlook potential opportunities for learning transfer that arise from many *other* members of a workgroup offering assistance to each other. Thus, we conclude that the lead user concept is less a role to be formally designated to one employee (or a few employees) per workgroup, and instead, a role that can be informally shared, at different times, among all (or most) coworkers. The high ratio of partial skills overlap among the subjects in our study is testament to such this.

By reframing the lead user role in this manner, we think that managers can encourage informal teaching and learning through both formal and symbolic organizational rewards. While undoubtedly complicated in terms of design and implementation, an incentive system could reward knowledge sharing among all employees, regardless of having a formally-designated role as trainer, lead user, etc. (Perlow 1997). Moreover, this would also avoid the potential problem of overburdening a single individual with the responsibility to serve as lead user (Rice et al 1999). While such a step effectively converts an informal learning method into a formal one, and thereby *encumbering* the lead user role (Brown and Duguid 1991), formal organizational rewards, including recognition during performance evaluations, may produce the desired behavior.

In taking on this challenge, management must be sensitive to the subtleties associated with the dynamics of knowledge sharing. For instance, Thomas-Hunt et al (2003) show that managers’ ability to effectively support the transfer of knowledge among coworkers may be constrained by group members’ levels of social connectedness (especially when social connectedness and social capital are low). In general, knowledge sharing dynamics emerge as a result of complex interactions between the amount of shared and unshared knowledge and other group level factors (i.e., social capital) to shape workgroup performance (Thomas-Hunt et al 2003). Any incentive system would have to account for these and other subtle influences in order to maintain workers’ belief in the fairness and parity of any incentive system.

Conclusion

From among several learning methods, informal learning among coworkers offers an effective means of raising employees’ knowledge levels (Kraut and Streeter 1995). While our study belongs to the small-yet-growing body of research on post-adoption IT learning, this stream of work is still somewhat new (Jaspersen et al 2005) so that we refrain from advocating informal, improvisational learning as a panacea to the problem of IT underutilization. Rather, informal learning is likely a complement to other methods of knowledge transfer, such as formal training, and providing formal “help desk” and competence centers (Eriksen, Axline, and Markus, 1999). Nevertheless, we believe informal learning merits further research attention, as it is one option available to managers that may be used to ameliorate the problem of inadequate or inappropriate IT usage (Adams 2006).

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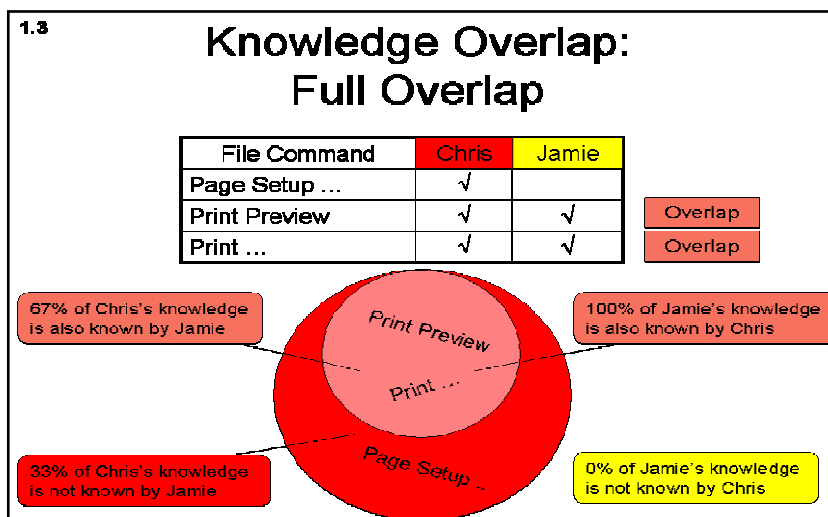
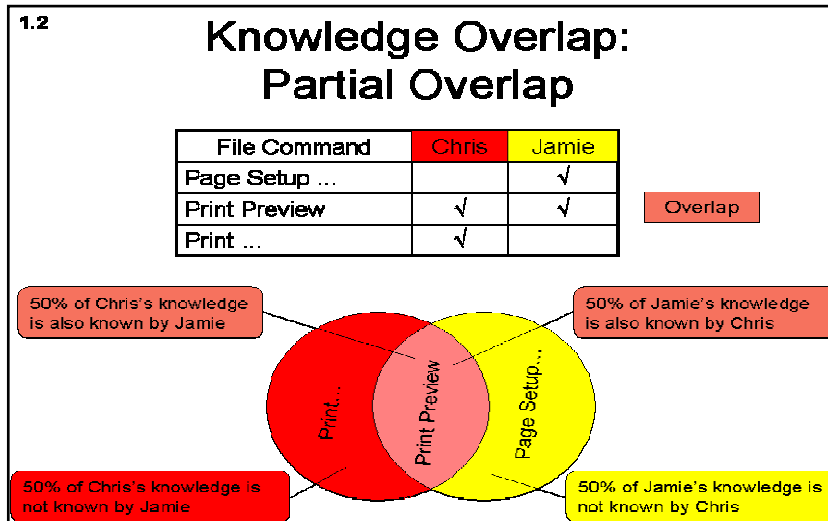
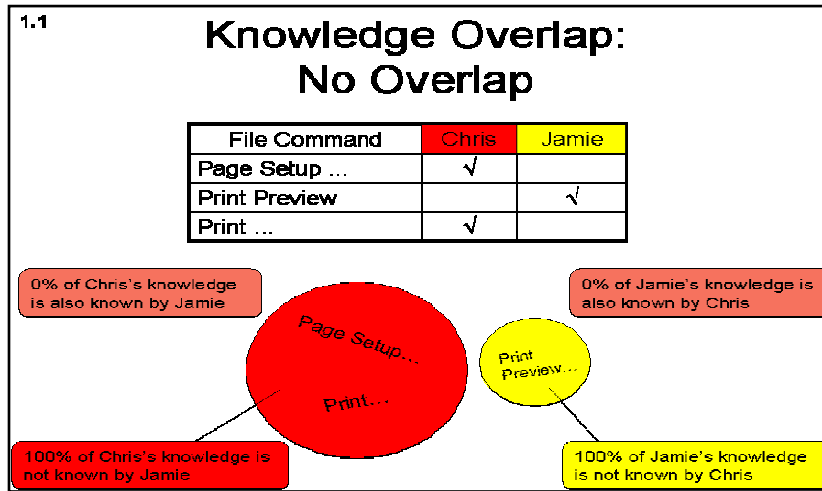
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Figures



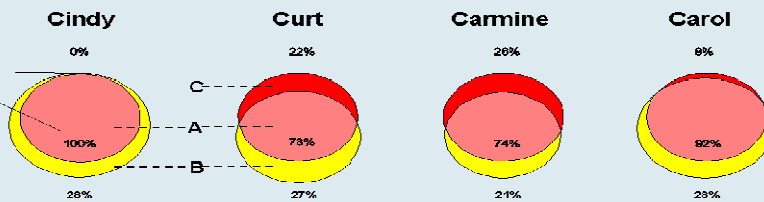
2.1

Cecelia

Word-processing

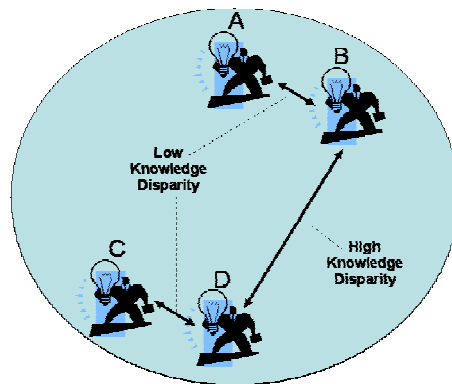
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0% of Cecelia's knowledge is not known by Cindy



3.1

Knowledge Disparity



3.2

Passive Initiator

