Individual Virtual Competence and Its Influence on Work Outcomes

YINGLEI WANG AND NICOLE HAGGERTY

YINGLEI WANG is an assistant professor at the Fred C. Manning School of Business, Acadia University, Canada. He received his Ph.D. from the Richard Ivey School of Business at the University of Western Ontario. His research interests include virtual organizations, knowledge management, e-learning, and information technology adoption. His work has been published in journals such as *Information & Management* and *Information Systems Journal,* as well as in various conference proceedings.

NICOLE HAGGERTY is an associate professor at the Richard Ivey Business School, University of Western Ontario. Her research interests center on the intersection of technology and learning/knowledge, including the influence of technical support on individual learning about technology, competency development, and learning and knowledge transfer in computer-mediated settings. Her research has been published in various scholarly journals and conferences, including *Information Systems Journal, Information & Management, Human Resource Management,* and *Journal of Organizational and End User Computing.*

ABSTRACT: Witnessing both opportunities and challenges in virtual work arrangements, researchers have explored a number of technological, social, and organizational factors in order to improve virtual work effectiveness. However, there is limited understanding of an important element of virtual work—the individuals. Our review of the literature indicates that the composition of individual knowledge, skills, and abilities (KSAs) required to work virtually would benefit from further research. In this study, we theoretically and empirically develop the construct of individual virtual competence that captures the key KSAs required to perform effectively in today's virtualized workplace, within a parsimonious nomological network. Substantiated by its explanatory power on individual perceived performance and satisfaction, individual virtual competence contributes to the literature by acknowledging a distinct workplace competency that can be incorporated in future individual-level studies of virtual phenomena. This research provides managers with a lens to understand differences in individual work outcomes and provides a lever to developing individuals' capabilities so as to improve work outcomes.

KEY WORDS AND PHRASES: individual virtual competence, individual work outcomes, virtual organization, virtual work.

TELECOMMUTING, VIRTUAL TEAMS, AND DISTRIBUTED COLLABORATION have gained popularity because they enable organizations to mobilize remote resources and create flexible

Journal of Management Information Systems / Spring 2011, Vol. 27, No. 4, pp. 299–333.
© 2011 M.E. Sharpe, Inc.
0742–1222 / 2011 $9.50 + 0.00.
DOI 10.2753/MIS0742-1222270410

work arrangements [90]. But research has also identified various challenges that virtual settings engender [58]. For instance, the influence of trust (a key precursor to virtual collaborative work and effective performance) and the difficulty of building trust in virtual settings have received much attention [39]. In response, researchers have proposed various approaches to researching and practicing virtual work [73]. Some have looked at the internal network structure of virtual organizations (e.g., [3]), whereas others have investigated interpersonal dynamics such as cohesiveness, trust, and conflicts among people within virtual organizations (e.g., [46, 64, 65]). Despite this, there seems to be limited research looking into individuals themselves according to recent literature reviews (see [59, 73]).

Individual characteristics play an essential role in virtual settings in determining the overall team or organizational performance [59]. The novelty of virtual work induces gaps between individuals' existing cognitive structures and the ones needed to perform work (e.g., [47]), which makes individuals and their limited capabilities a potential bottleneck in reaping benefits. Therefore, in addition to maintaining a task–technology–structure fit [73], organizations also need to align individuals with tasks, technology, and organizational structure to achieve optimal performance (e.g., [57]). Because such an alignment cannot be achieved without the understanding of the individuals, individual characteristics, especially those pertaining to coping with this new way of work, deserve more research attention.

In response, we examine the individual knowledge, skills, and abilities (KSAs) that are required to perform virtual work to enhance our understanding of the effects of individual characteristics. While prior research has emphasized specific virtual contexts such as globally distributed teams [39, 41], our work emphasizes the context of the virtualized workplace more broadly. We hold a continuum view of virtual work and target a bigger population of individuals. Characterized by distribution across various boundaries and heavy reliance on computer-mediated communication instead of face-to-face interactions, most work today exhibits *virtual* characteristics. What varies is the extent of the *virtualness* of an individual's work [22, 35]. For example, collocated individuals may elect to use e-mail or instant messaging to accomplish collaborative tasks, just as global virtual teams require the use of these tools. Virtual work is taking place in both situations, although collocated individuals can and do undertake their work at least partly in face-to-face interactions. Indeed, virtual work is an emerging and growing component of the day-to-day work of almost all knowledge workers [90].

Given this emerging work context, we theorize that individual virtual competence (IVC) is a new and distinct capability that individuals require in order to perform effectively in their organizations [92]. We use social cognitive theory [5] and pay particular attention to IVC as a novel ensemble of KSAs. Individuals who possess higher IVC are more effective than others within the workplace generally because they have the skills and abilities to orchestrate their expanding media toolkit and effectively interact with colleagues to accomplish their work as it transitions back and forth between virtual and physical activities, as portrayed by our continuum view of virtual work. We develop measures for the IVC construct and test them within a nomological network established by our theoretical development.

This study contributes to research and practice. First, we suggest a shift of research focus to the individual level when examining virtual phenomena and theorize that IVC is a key construct to consider. Its uses can range from our broad context of the performance of individuals in their virtualized workplace to the specific context of the performance of individuals on global virtual teams. Second, with IVC we elaborate three important dimensions of competence and their effects on an individual's work performance and satisfaction in the virtualized workplace. This expands the context-dependent, multidimensional view of competence suggested in prior competence research and advances theory. Third, we empirically develop the measures of IVC, providing a useful research instrument. Fourth, using perceptual measures of work outcomes, including satisfaction and perceived performance, our empirical results provide managers with insights into the kinds of development activities that they can engage in with their employees to advance their ability to undertake virtual work.

A Key Capability: Individual Virtual Competence

In this research, we follow a social cognitive approach to investigate individuals' KSAs. This perspective draws our attention to three tightly intertwined aspects of human development and performance: environmental changes, individual learning and cognition, and individual behaviors [5]. We use this causal flow to guide our theorizing and organize our empirical model as follows. Within the external environment, we see that virtual organizing and virtual work have become much more prevalent as more firms start to implement information and communication technologies (ICTs) to assist communication and collaboration [90]. Given that environmental change, we see that individual learning and cognitive development are occurring because many people are still adapting to this new way of working. They are learning how to leverage ICTs in order to perform their work as it ebbs and flows between collocated face-to-face environments and virtual environments that incorporate e-mail, online meetings and collaboration, and content management technologies that occur during the workday, at home, or while on the road [47, 85]. Consistent with social cognitive theory, research has indicated that individuals develop competence as a key learning outcome of coping with changes in environments, and cognitive changes like this in turn improve their performance [5, 49, 82]. Therefore, we focus on individual competence to understand important KSAs that enable individuals to perform effectively as they are increasingly called on to marshal a wide array of leaner media in their virtualized work environments.

Overview of Individual Virtual Competence

Individual competence in general is an important precursor to individual performance [82]. Competence refers to the state of having the necessary ability, motivation, skill, and knowledge that guides action [49, 82]. This definition suggests that individual competence is context specific, because different contexts may require different sets of ability, motivation, skill, and knowledge [57]. Consistently, researchers have theorized

about various types of competence to explain individual performance in a variety of contexts (e.g., [9, 48, 60]). For instance, in the information systems (IS) literature, studies have supported the positive relationship between context-specific types of competence and performance in information technology (IT) use and business–IT partnership [8, 9, 60]. In that research, context-specific types of competence include business competence in IT professionals, IT competence in business managers, and (end) user competence, which define the capability to use computer components (hardware, software, databases, etc.) and users' knowledge of IT concepts. Consequently, this stream of research requires study of the context within which the competence is deployed in order to derive its appropriate components relevant for that context. Contributions to competence research emerge from systematically defining new, relevant contexts and new types of competence that add to the choice set, which researchers can then use to study individual-level phenomenon. This is the approach we follow in our research.

Applying the theory of competence in the context of virtualized work, we define the construct of IVC as an individual's KSAs to collaborate and communicate with others in virtual environments for the purpose of completing collaborative work [92]. Consistent with the effect of individual competence in other contexts, and given our continuum view of virtual work (i.e., all work is more or less virtual, not all work is either virtual or not), we argue that people with higher levels of IVC will perform their work activities better than individuals with lower levels of IVC.

We treat IVC as a multidimensional construct. Prior research on competence has theorized that competence generally consists of multiple components, such as a cognitive component, a skill-based component, and an affective component [49, 57]. Each component pertains to a specific aspect of work and contributes to individual performance in conjunction with the others. However, the composition of competence is not static. The embodiment and the relevance of a component depend on the context in which competence is discussed [82]. For instance, in the study of the IT competence of business managers, only IT knowledge, experience with IT, and vision are included, because they are salient in explaining business managers' performance in promoting and leveraging IT [9]. Therefore, we define IVC as a multidimensional construct and identify below its components in virtual settings. In order to determine appropriate dimensions, we followed a two-step process. First, we sought guidance from the general competence literature as to the general types of competence components to include in our conceptualization of IVC. Second, we went into the literature on competence specific to the IS field and also the virtual work literature to identify the specific components that we interpreted to fit the context of individual performance in the virtualized work that is emerging in organizations today.

In well-cited research, Spencer and Spencer [82] postulate that general competence at work consists of five components: motives, traits (such as eyesight), self-concept, knowledge, and skill. However, from a developmental perspective, prior research suggests that the focus of research on human competence at work should be on self-concept, knowledge, and skill, because motives and traits reflect core personality/physical condition and are difficult to change [79]. This argument is echoed by the current

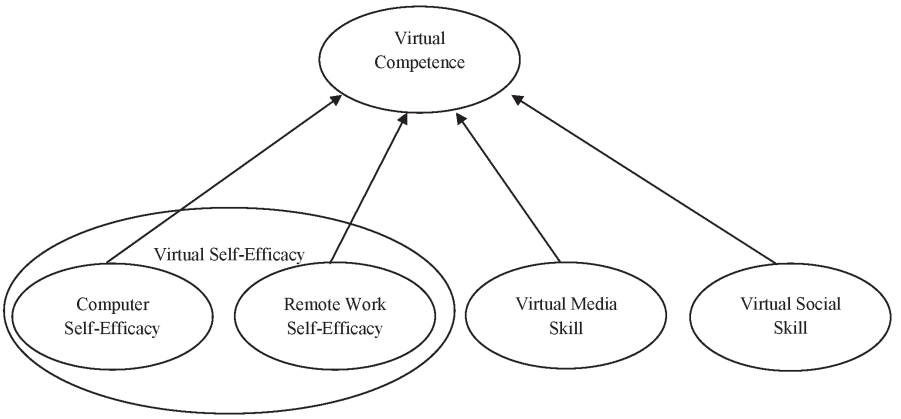

Figure 1. Virtual Competence as a Multidimensional Construct

conceptualizations of competence in the IS field where context-specific knowledge, skill, and beliefs are the three most common components of competence because of their importance in determining individual performance in computer-mediated contexts (e.g., [9, 57]). Therefore, and consistent with the trend in IS research, we adapt Spencer and Spencer's [82] general framework.

We then identified dimensions of IVC by reviewing the IS user competence and virtual work (including virtual teams, virtual organizations, remote collaboration, online communities, etc.) literature. We looked for two issues that either theoretically or empirically were influencing individual work outcomes in those virtual settings: (1) the three components of competence, which are individual self-concepts, knowledge, and skills, and (2) fundamental difficulties inhibiting performance. With the former, we are able to incorporate prior research findings and ensure breadth of coverage of the IVC construct. The latter gives us the opportunity to theorize about the new elements of individual competence that are essential to cope with virtual work.

We synthesized the findings in the literature and theorize that IVC consists of three essential dimensions: virtual self-efficacy, virtual media skill, and virtual social skill [92]. Figure 1 depicts our conceptualization of IVC, and Appendix A lists the key studies that informed our choice of each dimension. Essential to our theorizing is the conceptualization of IVC as emerging from distinct components that combine to form a parsimonious multidimensional abstraction in the same manner that, for example, job satisfaction represents a parsimonious abstraction of a summed aggregate of dimensions such as satisfaction with pay, with colleagues, and promotion opportunities [52]. Theoretically, we suggest that IVC is not a latent construct underlying virtual self-efficacy, virtual media skill, and virtual social skill. Rather, our position, supported by prior work on general competence [82], is that the construct of IVC only exists as a combination of the dimensions of which it is composed. The combination of these three dimensions then signifies the amount of IVC an individual possesses. Specification of this theoretical position is required in order to determine

the appropriate empirical treatment of IVC and to aid in interpreting our results. We explain each dimension in the following sections.

Dimensions of Individual Virtual Competence

Virtual Self-Efficacy

The first dimension, *virtual self-efficacy,* represents the self-concept component of competence in virtual settings. Self-efficacy is an individual's belief in his or her abilities to engage in certain behaviors [5]. Self-efficacy belief influences individuals' perseverance when encountering challenges. Strong self-efficacy beliefs foster mastery in various situations because individuals rely on self-confidence in their abilities to persist through challenges. In our virtualized work context, virtual self-efficacy describes an individual's belief in his or her abilities to use information communication technologies and accomplish work tasks virtually [92]. It is the key self-concept that enables individuals to cope with and persist through difficulties within virtualized work settings [85].

Virtual self-efficacy comprises two dimensions: computer self-efficacy (CSE) and remote work self-efficacy (RWSE) [92]. CSE is an individual's belief in his or her ability to use computer technology broadly [24]. Given that ICTs are the basis of virtual organizations, individuals' performance in virtual settings requires the confidence to work with the broad variety of computer technologies at their disposal [33]. CSE is thus a critical self-concept that deals with the challenges caused by technologies in virtual settings. The other subdimension is more task related. RWSE refers to an individual's belief in his or her ability to work and perform joint tasks with others in virtual settings [85]. It describes the confidence of individuals to function in their work role without face-to-face interactions. Because individuals need to cope with challenges caused by both newly deployed ICTs required to do their work and the new way of collaborating in order to accomplish tasks in virtual settings [47, 85], both CSE and RWSE are essential components of virtual self-efficacy that reflect salient self-concepts.

Virtual Media Skill

Virtual media skill (VMS) is the second dimension in the theorizing of IVC. It describes an individual's skill level (versus his or her confidence as in self-efficacy above) in using technologies to communicate in virtual settings to their full potential [92]. The importance of VMS stems from the fact that virtual work depends on effective communication via ICT usage [47]. Lack of skill in using computer technologies impairs an individual's capability to accomplish tasks in virtual settings. VMS represents the skill component of IVC, and unlike virtual self-efficacy, it is performance oriented rather than belief oriented. It taps into the actual ability of individuals to leverage technologies in various situations, emphasizing "how to" rather than "know what." Using technologies might be simple; however, being able to exploit their potential

in virtual settings requires more comprehensive understanding and capability, and proves to be much more valuable. For instance, most people have some ideas about the functionalities of e-mail; however, some people can transmit rich information and create timely discussion and collaboration via e-mail, whereas others with less skill can only use it as an alternative to traditional letters and memos [53]. Therefore, each individual will have his or her own level of skill in using ICTs beyond a basic understanding of them.

Virtual Social Skill

The last dimension of IVC is *virtual social skill* (VSS). Social interactions are critical factors for successful virtual operations because they facilitate collaboration by fostering healthy interpersonal relationships [2, 66]. However, the distributed essence of virtual work makes it difficult to build important relationship characteristics such as trust with co-workers [39]. It may require a different set of knowledge and skills from the one in traditional settings to interact with people because face-to-face interactions are absent. VSS thus captures this emergent skill set and describes an individual's ability to build social relationships with others in virtual settings [92]. VSS is representative of both the knowledge ("know what") component and the skill ("how to") component of competence in virtual settings. It reflects individuals' understanding of the uniqueness of social activities in virtual settings and the skill to deal with it. For instance, emotion in traditional settings could be detected by facial activities and body gestures. In virtual settings, one needs to have the knowledge and skill to interpret a series of text expressions and emoticons (such as :) and : (or the use of CAPITALIZATION, "quotation marks," and exclamation marks!!!) in order to grasp emotions that people intend to—or sometimes do not intend to—convey. Therefore, the understanding and ability to interpret and apply emerging social protocols constitute a significant part of an individual's capability to perform in virtual settings.

Based on the social cognitive perspective [5] and the general framework of competence at work [79, 82], we argue that these three dimensions of the construct of IVC reflect self-concept, knowledge, and skill attributes of individuals in virtual settings. Importantly, these competence domains also address the cognitive, technical, and social challenges raised in the virtual organization literature [92]. Prior research suggests that people may feel uncomfortable and insecure with virtual work because it seems unnatural to them [47]. We believe that virtual self-efficacy is a key belief in this case because it motivates individuals to persist in coping with new and sometimes difficult environments. Research also suggests that virtual work suffers from inefficiency because individuals are unable to interact with each other as effectively as in traditional settings [39]. This could be due to unfamiliarity with features of the media or unfamiliarity with social protocols [47, 85] that assist in carrying out this work. VMS and VSS correspond to these issues. They represent the knowledge and skill an individual needs to accomplish work collaboratively with others in virtual settings. Thus, the theorizing of IVC is consistent with key issues identified in the virtual organization literature.

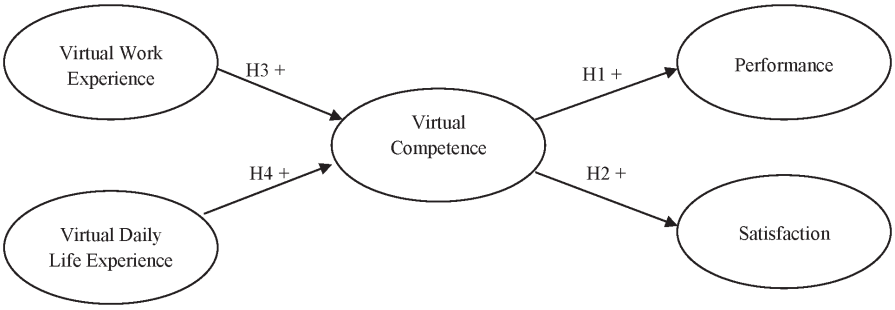

Figure 2. A Conceptual Model of Virtual Competence and Work Outcomes

A Nomological Network to Test Individual Virtual Competence

DRAWING ON BANDURA'S [5] SOCIAL COGNITIVE THEORY, we develop a parsimonious nomological network to test IVC in keeping with accepted practice [27]. This model adopts the theory's three components of behaviors, environments, and individual cognitive and other personal factors to understand individual work outcomes (e.g., [85]). The broad theoretical argument of our model is that past experiences with virtual activities help people build competence to perform effectively in their present virtual settings, which in turn influences their work outcomes of job performance and satisfaction (as shown in Figure 2).

We emphasize broad work outcomes rather than specific virtual work outcomes because our context is the general work setting in which virtual work occurs along a continuum and contributes to broad work outcomes—a reality within most contemporary organizational settings. According to Chudoba et al. [22], virtuality is a matter of degree; as long as people occasionally rely on computer-mediated communication in addition to face-to-face interactions to cooperate on tasks, the work setting has a degree of virtuality. In this sense, everyone experiences virtual work to some extent whether it is working from home, working in global teams, or even exchanging ideas with co-workers on the same floor by e-mail. As a result, generalized work outcomes such as job satisfaction and performance would rely on an individual's successful virtual work practices. Furthermore, as an initial test of our theorizations about IVC, examining its relationship to broad work outcomes (versus specific virtual outcomes such as performance in virtual teams) provides a more conservative test. Prior research usually focuses on highly virtual settings, such as geographically distributed virtual teams (e.g., [39, 40]). Given our continuum view of virtuality, we would expect that a specific virtual team context would lead to a very optimistic estimation of the effects of IVC because we expect that such competence would be very influential in settings of high virtuality. Alternatively, in a work setting where everyone is in the same office area and it is convenient to talk to people just by walking to their cubicles (e.g., the editorial office of a newspaper), the skill to build relationships online (VSS) and the confidence in working with people remotely (RWSE) are less likely to be mobilized and thus may be less relevant to performance. In cases such as this, the effects of

virtual competence may not appear as strong as in highly virtual settings. Broad work covers all the work arrangements that individuals are involved in, some more virtual and some less virtual, and thus demonstrates a lower level of virtuality on average than specific virtual teamwork. This makes it more difficult to detect IVC's effect, because as a particular set of KSAs facilitating virtual work, it may be less influential in settings with lower virtuality. Yet given a continuum view of the virtualized workplace, it remains a relevant context to investigate the influence of virtual competence. If we find the effect of IVC in this case, we could make the inference that IVC indeed matters with more confidence and to a broader set of modern work situations than only examining specific virtual work outcomes.

Our model argues that the ensemble of KSAs that constitutes IVC influences individual work performance. First, individuals face difficulties caused by ICTs as well as the new way of working that these technologies engender [85]. According to social cognitive theory, self-efficacy influences performance because it determines the persistence and effort of individuals when undertaking tasks [5]. Thus, individuals who have higher virtual self-efficacy (both CSE and RWSE) are likely to outperform others because they are more motivated to persist when encountering the emergent difficulties in virtual settings. Second, VMS determines the extent to which individuals can leverage technology in virtual settings. Individuals exhibit diverse skill in using ICTs [47]. With better VMS, an individual is able to transmit a larger quantity and richer quality of information by dexterously using various media [14], and this enables better performance due to the increased efficiency and effectiveness of communication. Third, VSS facilitates collaboration because it helps the individual handle interpersonal relationships, such as building trust and managing conflicts (e.g., [40, 71]). Individuals with better VSS are more effective in building necessary relationships with others, and this reduces the transaction cost associated with collaboration and improves performance in virtual settings [39, 56]. Overall, our theoretical arguments are consistent with the position that a high level of virtual competence is likely to lead to superior work performance. Therefore, our first hypothesis states:

Hypothesis 1: IVC is positively related to individual job performance.

IVC also influences individuals' job satisfaction via various mechanisms, including social interactions with people and self-evaluation [44, 54]. Prior research suggests that individuals' job satisfaction may result from positive interactions with people, for example, managers and peers, in their social environments due to the fulfillment of social needs (e.g., social support) [77]. As we have theorized, those who have high IVC are highly capable of interacting harmoniously with others and can even make friends in virtual settings (e.g., [2]). Hence, this capability helps maintain a positive social environment, which in turn increases job satisfaction. Furthermore, in the psychology literature, self-efficacy as a component of core self-evaluation is found to relate positively to job satisfaction [43]. The reason for this relationship is that individuals with high self-efficacy tend to look at the positive sides of work and perceive challenges in work as fulfilling rather than annoying [12]. In our case, this logic suggests that a lack of IVC as manifested in low virtual self-efficacy causes an individual to be

pessimistic and feel frustrated rather than excited when encountering difficulties, and this leads to job dissatisfaction (e.g., [45]). Therefore, we hypothesize:

Hypothesis 2: IVC is positively associated with individual job satisfaction.

Having discussed the effects of IVC, we now examine the antecedents of IVC. From a social cognitive perspective, individuals develop cognitive traits and other personal characteristics through prior behaviors or via interactions with environmental contexts [5]. For instance, research finds that individuals gain CSE and RWSE through using computers and experiencing prior remote work [85]. In this vein, we propose that IVC can be developed when individuals have conducted activities in virtual settings in the past [92].

Experience with virtual work enhances all aspects of IVC. According to channel expansion theory, prior experience with media influences individuals' capabilities to use them [14]. By using ICTs at work, individuals develop the know-how to apply the "lean" media to convey rich information to various partners about diverse topics and in different contexts. As a result, they become skillful with the media (VMS). Similarly, virtual work provides the environment in which individuals practice their VSS. Through interactions, individuals accumulate knowledge about the uniqueness of social activities in virtual work settings, develop strategies to cope with the uniqueness, and eventually become savvy players in the new virtual setting [47]. In addition, self-efficacy corresponds to the increase of experience; self-efficacy theory posits that individuals develop confidence in their abilities by observing others, conducting relevant activities, and evaluating themselves [5, 85]. In virtual work, people observe how others use ICTs and collaborate with colleagues, and they practice these activities themselves. This observational type of education represents a major mode of learning in social cognitive theory. After a few iterations, individuals learn and gain confidence when they see themselves actually functioning in virtual settings. In other words, this learning process strengthens their virtual self-efficacy. Overall, we hypothesize:

Hypothesis 3: Individuals who have been involved in more virtual work activities in the past will develop greater IVC.

The development of IVC also happens in daily life. With the development of ICTs, activities based on ICTs become more accepted in our daily life, well beyond the virtual workplace [17]. For example, Internet-based activities are flourishing—people chat, shop, bank, and even date online [7, 37, 63]. In essence, the activities people conduct online in daily life are similar to what they do in virtual work. First, similar technologies dominate use in both settings [38]. ICT applications, such as e-mail, instant messaging, and video chat (conference), have been widely adopted at home and work [36, 37]. Second, people use these technologies for similar activities at work and in their daily life. At home, we seek information, communicate with others, and participate in group activities online [83]. These activities, although different in content, are not especially different in process from the activities that support the operation of virtual work (see [73]). Therefore, the online activities of daily life provide relevant opportunities for individuals to develop capabilities in activities based on ICTs, which may

assist them in the workplace [38]. Thus, using the same mechanism that explains the effect of prior virtual work experience on the development of IVC, we hypothesize:

> *Hypothesis 4: Individuals who have been involved in more online activities in their daily life will develop greater IVC.*

Methodology

A SELF-REPORT ONLINE SURVEY DESIGN WAS ADOPTED to test measures as well as hypotheses. Following prior research (e.g., [85]), we adopted perceptual measures of our theory, including perceived performance, which is believed to be as predictive as other methods, though at times inflated [74, 89]. Given the exploratory nature of this study, we had two stages of data collection: a pilot and the main data collection. The pilot study was used to refine construct measures and the entire measurement instrument. In this section, we report the operationalization of constructs and the data collection methods. Appendix B provides a detailed list of survey items and indicates their formative or reflective treatment and if they are first order or second order.

Individual Virtual Competence Measure Development

Consistent with our theoretical development, we treat IVC as a second-order construct that is empirically formed by its dimensions. Treating IVC as a second-order construct suits our purpose of construct development very well because it can describe precisely the multidimensional nature of IVC as well as allow assessment of measurement quality by conventional indices (see [55, 67]). The common practice for a multidimensional second-order construct is to measure its dimensions respectively and use the scores, such as factor scores or construct scores, of the dimensions as the indicators of the overall construct [10, 19, 52]. Following this method, we thus measure general CSE, RWSE, VMS, and VSS as the indicating dimensions of IVC. In addition, we treat these dimensions of IVC as formative indicators because, as previously discussed, they aggregately form IVC instead of reflecting it as an overarching construct. Reflective indicators are empirically inappropriate in this case because they imply a relationship between indicators as different ways to express the same overarching construct [11, 23].

We adapted the two components of virtual self-efficacy from prior research. The measures of general CSE were adopted from Compeau and Higgins's [24] items, and the measures of RWSE were adapted from Staples et al.'s [85] items.

The measures of VMS were developed through two steps. First, we used Saunders's [80] summary of virtual teams to identify relevant media types. We included telephone, e-mail, videoconference, instant messaging, online forum, and group support systems. Second, based on prior research [94], we created four items for each media type to ask individuals about their skill in using a certain medium to give and receive timely feedback, to convey multiple types of information, to transmit varied symbols, and to tailor information according to needs, respectively. Consistent with the construct

of IVC, VMS exists theoretically as an aggregation of its underlying dimensions as defined by different media types. Therefore, we empirically treat the items as formative indicators of VMS [11].

We adapted the measures of VSS from Ferris et al.'s [31] measures of general social skill. We modified the wording of the items to reflect our research context.

Measures of Other Constructs in the Research Model

The measures of other constructs were all adapted from existing studies and were modified to seven-point Likert scales when applicable. We drew our dependent measures from prior virtual work research of individual work outcomes [84, 85]. We measured perceived performance (an individual's perception of his or her effectiveness and efficiency when performing his or her job) by a six-item scale, and job satisfaction (an individual's level of contentment with his or her job) was also measured with a six-item scale.

Virtual work experience refers to the experience of working with others (collaborating on tasks, work assignments, or projects) using ICTs for communication and coordination (rather than solely face-to-face communication). We measured virtual work experience with two items, the first using an individual's degree of experience and the second using the frequency with which he or she has performed virtual work in the past three years [51].

Virtual daily life experience represents the part of people's nonwork life where they interact with each other (friends and family) and with organizations (e.g., banks, online stores, information Web sites) using ICTs, most often the Internet. Most frequently these activities take place during personal time. However, they may take place during work hours as well. These activities can be grouped into three categories: information seeking, communication, and socialization [87]. Experiences with these three dimensions constitute an individual's overall virtual daily life experience. Following the theoretical logic of our discussion of multidimensional constructs above, we treat people's experiences with these three groups of activities as formative indicators of virtual daily life experience because they are theoretically distinct and do not necessarily co-vary. We gauged the experience with each type of activity by an individual's frequency and daily duration of the activities.

We controlled for the effects of age, gender, education, and the degree of virtuality of the current work setting on perceived job satisfaction and perceived performance within this research. We adopted the definition and measures of virtuality from Chudoba et al.'s [22] research. It is a second-order construct with formative indicators that has three dimensions: workplace mobility, team distribution, and variety of practices.

Pilot Study

To refine the instrument, we put all the measures through a pilot study conducted with a group of MBA students at a North American business school. We posted the

questionnaire on an internal Web site of the school and invited students to participate voluntarily. Fifty-two responses were received after two reminders. The analysis of the data identified a few issues and we adjusted the measures accordingly.

First, we trimmed the CSE measure due to respondent fatigue and in keeping with Dillman's [29] advice. Given satisfactory pilot results (Cronbach's $\alpha = 0.94$), we took the five items of CSE with the highest loadings in the pilot study and used them in the large-scale survey. We presented the shortened scale and relevant results to one of the original inventors of the CSE scale [24], who deemed this treatment acceptable.

Second, we discarded several items for RWSE. A factor analysis of the 16 original items for RWSE revealed that many of them were heavily loaded on other constructs. A close examination of the items showed that these items might indeed pertain to different aspects of remote work. For instance, one item is "To aid in performing my job, I could use a fax machine to send documents," which is less about the nature of remote work and more about the use of technologies. Because our research has constructs such as VMS, it is not surprising that this item had high cross-loadings on other constructs. In fact, in the original research, RWSE was measured by an overall score "computed by summing these 16 items" [85, p. 765] rather than testing the 16 items directly in partial least squares (PLS) analysis. Thus, in the original study, individual items were not examined and multidimensionality was not checked. Therefore, based on the results of our factor analysis, we selected the four items pertaining to the remote work mode itself, which we believe reflect the essence of RWSE ("employees' confidence that they can work effectively in a remote environment" [85, p. 760]), to maintain the unidimensionality of this construct.

After these changes, we analyzed the data using PLS structural equation modeling. The shortened scales and other measures demonstrated satisfactory reliability, convergent validity, and discriminant validity in general (see [6, 18, 62]). Therefore, we established confidence in the measures and applied them in the large-scale data collection described next.

Data Collection

The data collection was conducted with the alumni of a North American business school. These alumni represented a good sample because we wanted to investigate knowledge workers who represent different organizational contexts and different functional and hierarchical positions to give the broadest possible test of our work. The sample was selected randomly across all alumni of the business school on the basis of three criteria: (1) the participants had to have knowledge work jobs, (2) the participants should not be C-level executives (e.g., chief executive officer, chief information officer), and (3) the participants should have a mix of work experience defined by the years since graduation.

An online survey was set up on the Internet to collect responses. Compared to traditional paper-based questionnaires, online surveys have advantages of greater speed and lower cost [29]; however, they may introduce the response bias that only people who are comfortable with using computers and the Internet will respond [25]. Because our

interest was in knowledge workers who use computers to work by themselves and with others, we judged that this concern was unlikely to influence our results. Therefore, the online survey method was adopted due to its efficiency and effectiveness.

Procedures suggested by Dillman [29] that maximize response rate were followed. First, we e-mailed an invitation message to the participants with a link to the online survey. Three days later, a reminder was sent out to nonrespondents. Another three days later, the last follow-up e-mail was sent to nonrespondents to lift the response rate.

Over a three-month period, we sent out 976 invitations with 76 being returned as undeliverable. During this time, 199 responses were received for a response rate of 22.1 percent. Among the 199 received responses, 23.1 percent were from female participants and 76.9 percent were from male respondents, which is representative of the invitation group (76 percent male and 24 percent female). MBA recipients represented 77 percent of the respondents, 20.4 percent held bachelor's degrees, and a few had Ph.D.s. They worked in a variety of industries, including manufacturing, financial services, consulting, and trading. The average age of respondents was 41 years.

Results

To test measures and hypotheses, PLS structural equation modeling was used in this study due to its capability of examining measurement and structural models simultaneously and working with relatively small samples [18, 20]. Following prior research that uses second-order constructs, we adopted a two-step approach in which we created two PLS models [4, 10, 19, 21] (see Appendix C for the details of our model construction, which supports our description below).

In the first step, we derived construct scores of first-order constructs in a PLS model by entering first-order constructs with direct paths to other constructs as theorized. For IVC, we derived construct scores for CSE, RWSE, VMS, and VSS. For virtual daily life experience, we derived construct scores for information seeking, socialization, and communication. Also, the control variable of virtuality required that we develop construct scores for the first-order dimensions of workplace mobility, team distribution, and variety of practices. Then we used the scores of each of these first-order constructs as indicators of their respective second-order constructs (of IVC, virtual daily life experience, and virtuality) and constructed a second model using the second-order constructs to test our hypotheses. The computer program we used was SmartPLS version 2.0.M3 [78].

We assessed the measurement model by item loadings, reliability, convergent validity, and discriminant validity. The hypotheses were tested by examining the *t*-statistics of path coefficients. In the following sections, we first present the results of our analysis of the measurement model to demonstrate construct reliability and validity (as appropriate for each of the constructs depending on whether they have formative or reflective items). Subsequently, we offer the results of the structural model that we used to draw conclusions about virtual competence.

Measurement Model

Table 1 presents the descriptive statistics and intercorrelations of the constructs in the structural model.[1] Table 2 reports the reliability and AVE of each construct with reflective items in the structural model and the loading of each item on its underlying construct. In our measurement of IVC as a second-order construct, we use reflective items to measure some of its first-order dimensions, namely, CSE, RWSE, and VSS, whereas VMS is a first-order construct with formative items. To fully appraise the measurement properties of our constructs, the reliabilities and validities of the first-order constructs need to be examined together with the other reflective measures. Therefore, the reliabilities, AVEs, and item loadings of the first-order constructs are also included in Table 2.

As noted, several of our constructs are second order with formative indicators, and this has implications for the interpretation of our results. In PLS analysis, we processed this type of construct by first calculating the construct scores of the dimensions and then linking them to the second-order constructs as formative indicators [4, 10, 19, 21]. These second-order construct indicators do not reflect the underlying constructs, but form them. As a result, the second-order construct indicators of an underlying construct may not be correlated with each other, as reflective indicators are interrelated [11]. In this case, common statistical indices of measurement quality, such as reliability, discriminant validity, and convergent validity, are not applicable [18, 23]. Therefore, we do not report these indices for these second-order constructs; instead, we include weights of formative indicators because weights signal the contributions of indicators to their corresponding second-order constructs [18]. Table 3 summarizes the weights of the formative indicators of second-order constructs. As above, in order to fully appraise the measurement properties of all of our constructs, we also include the weights of the formative indicators of first-order constructs (VMS, the dimensions of virtual daily experience, and the dimensions of virtuality) to show evidence of their performance.

Our reflective measures exhibit acceptable reliability. In PLS analysis, reliability is indicated by composite reliability [6]. To achieve acceptable reliability, the composite reliability of each construct should be higher than 0.7 [62]. In Table 2, all the reflective constructs reach this threshold.

Our reflective measures also show good convergent and discriminant validities. According to Table 2, the AVEs of all the constructs with reflective items are higher than 0.5, suggesting satisfactory convergent validity [18, 32]. Also using an analysis of item loadings and cross-loadings,[2] we concluded that all the items have higher loadings on the constructs they intend to measure than on other constructs, which meets the criterion for acceptable discriminant validity.

In Table 3, the formative measures should be evaluated based on the significance of their weights, which indicate their contributions to their corresponding constructs [18, 19]. The two dimensions of IVC (CSE and VSS) and the two dimensions of virtual daily life experience (information seeking and socialization) are not significant contributors

Table 1. Descriptive Statistics and Correlations of Structural Model Constructs with the Square Roots of AVEs on the Diagonal

Constructs	Mean	Standard deviation	1	2	3	4	5	6
1. Performance	5.89	0.85	0.85					
2. Satisfaction	5.24	1.20	0.40	0.81				
3. Virtual competence*	5.01	0.81	0.58	0.39	n/a			
4. Virtual daily life*	3.86	0.88	0.19	0.05	0.29	n/a		
5. Virtual work experience	5.62	1.37	0.04	0.11	0.30	0.15	0.89	
6. Virtuality*	3.89	1.49	0.23	0.31	0.38	0.32	0.42	n/a

Notes: * Noted constructs have formative items. It is not appropriate to calculate AVE because such constructs do not reflect the underlying measures but are formed based on them. Thus the concept of the average degree to which items correlate with the construct does not apply. n/a = not applicable.

Table 2. Reliabilities, AVEs, and Item Loadings of Constructs with Reflective Items

Construct/item	Loading
Performance (composite reliability = 0.93, AVE = 0.72)	
PER2	0.79
PER3	0.88
PER4	0.79
PER5	0.92
PER6	0.84
Satisfaction (composite reliability = 0.92, AVE = 0.66)	
SAT1	0.86
SAT2	0.73
SAT3	0.75
SAT4	0.80
SAT5	0.88
SAT6	0.83
Virtual work experience (composite reliability = 0.88, AVE = 0.79)	
VWE1	0.98
VWE2	0.79
First-order reflective constructs	
Computer self-efficacy (composite reliability = 0.90, AVE = 0.65)	
CSE1	0.83
CSE2	0.83
CSE3	0.84
CSE4	0.79
CSE5	0.75
Remote work self-efficacy (composite reliability = 0.85, AVE = 0.65)	
RWSE2	0.83
RWSE3	0.79
RWSE4	0.80
Virtual social skill (composite reliability = 0.89, AVE = 0.61)	
VSS1	0.75
VSS2	0.84
VSS3	0.80
VSS4	0.73
VSS5	0.79

to their constructs in this context.[3] Thus, we found partial support for the dimensions of the IVC construct as theorized and tested within this sample group. Nevertheless, both are newly created measures in the field, and strong theoretical justification has been made for their presence. On that basis, we retain these dimensions in our analysis and discuss implications and future recommendations below (e.g., [75]).

Structural Model

We tested our research hypotheses by examining the coefficients and the significance levels of the paths in the model we created in the second step of our analysis. We used

Table 3. Weights and Loadings of Measures of Both First- and Second-Order Constructs with Formative Items

Construct	Indicator	Weights
Second-order constructs with formative items		
IVC	Computer self-efficacy	0.05
	Remote work self-efficacy	0.43***
	Virtual social skill	0.03
	Virtual media skill	0.68***
Virtual daily life experience	Information seeking	0.05
	Communication	0.83**
	Socialization	0.23
Virtuality	Workplace mobility	0.28
	Variety of practices	0.44
	Team distribution	0.57**
First-order constructs with formative items		
Information seeking	INFOR1	0.24
	INFOR2	0.91***
Communication	COM1	0.72**
	COM2	0.50
Socialization	SOC1	0.68**
	SOC2	0.42
Workplace mobility	MOB1	0.08
	MOB2	0.11
	MOB3	–0.15
	MOB4	0.94**
	MOB5	0.01
Variety of practices	VAR2	0.63**
	VAR3	0.53**
Team distribution	DIS1	0.06
	DIS2	–0.08
	DIS3	–0.13
	DIS4	1.04***
Virtual media skill	VMS1	0.23
	VMS2	0.37**
	VMS3	–0.13
	VMS4	0.26
	VMS5	–0.26
	VMS6	0.32
	VMS7	–0.17
	VMS8	0.09
	VMS9	0.07
	VMS10	0.25
	VMS11	0.10
	VMS12	–0.14
	VMS13	0.01
	VMS14	0.09
	VMS15	0.25
	VMS16	–0.38
	VMS17	–0.04
	VMS18	0.62**
	VMS19	0.18

(continues)

Construct	Indicator	Weights
	VMS20	–0.11
	VMS21	–0.16
	VMS22	0.10
	VMS23	0.25
	VMS24	–0.29

Notes: The indicators of second-order constructs are the construct scores of corresponding first-order constructs. ** $p < 0.05$; *** $p < 0.001$.

bootstrapping to generate *t*-statistics with the resampling option of 500 subsamples of the size of 199. Figure 3 reports the standardized path coefficients with significance levels and the variance explained in endogenous constructs.

As shown in Figure 3, and as expected, all the paths are significant at the 0.001 level. IVC is significantly related to individual perceived performance with a coefficient of 0.56. Thirty-six percent of the variance in perceived performance is explained. These results support Hypothesis 1. IVC is also positively associated with job satisfaction with a coefficient of 0.31 and 18 percent of the variance in satisfaction is explained. Therefore, our findings also support Hypothesis 2. The coefficient between virtual work experience and IVC is 0.27, suggesting that virtual work experience is a significant antecedent of IVC. This supports Hypothesis 3. Finally, we found that virtual daily life experience is significantly related to IVC and the coefficient is 0.25, which provides support for Hypothesis 4. Together, virtual work experience and virtual daily life experience explain 16 percent of the variance in IVC. None of the control variables is significantly related to perceived performance or job satisfaction. Overall, the data support the proposed model.

Discussion, Limitations, and Future Research

Our study demonstrates that individuals who have higher IVC exhibit higher perceived performance and are more satisfied with their jobs. The trajectory for contemporary workplaces is greater adoption and use of technologies. As workplaces evolve and workers engage in more frequent, seamless transitions between virtual work and local face-to-face work, IVC will become an increasingly important capability in order to maintain productivity and effectiveness.

Today, organizations are struggling to absorb two environmental shifts that we believe will make understanding IVC even more influential in the future workplace. First the millennial generation entering the workforce today is perceived to hold different capabilities with technology and different expectations of their work environment [81]. Millennials are generally thought to bring stronger confidence with technology and greater facility with using it in the workplace than baby boomers or Generation X workers. Although our research in this paper did not confirm this specifically, we would expect that mapping IVC across a firm's workforce and then developing plans to meet the needs of different workplace generations would be an important activity

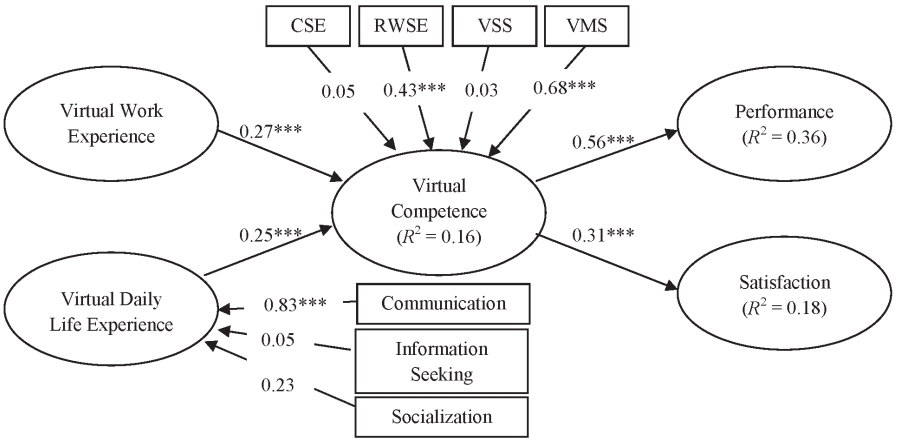

Figure 3. Structural Model Results with First-Order Constructs and Their Weights

Notes: CSE = computer self-efficacy; RWSE = remote work self-efficacy; VSS = virtual social skill; VMS = virtual media skill. *** $p < 0.001$.

in order to facilitate effective virtual work. A second trend is the emergence of social media. Firms see these platforms (albeit with some skepticism presently) as an innovation that will finally support more effective knowledge sharing and information exchange [1]. We believe that cultivating IVC within the workforce will enable firms that adopt social media to maximize its effective use because individuals with higher virtual competence will be more effective at transferring knowledge using these technologies [92]. Based on our research about virtual daily life activities, we would also suggest that social media use outside the firm context may be one daily life activity to actually encourage rather than block (e.g., blocking Facebook at work) [1], because it could be a mechanism to enhance IVC at work.

We believe it is a particular strength of the current work to find a reasonably high explanatory power between IVC and our outcome measures of perceived performance (36 percent) and satisfaction (18 percent) across a wide variety of occupations and industries and levels of virtuality present in the work of our respondents (including technology firms, banks, and insurance, manufacturing, and trading companies). The positions they held ranged from professionals (i.e., consultants and accountants) to managers. This group also practiced virtual work activities on a monthly basis with a mean of 3.89 on the virtuality scale. This reinforces our view of virtual work as a ubiquitous phenomenon. Specific occupations or industries might even have a higher degree of virtuality.

From a measurement standpoint, we demonstrated the validity of IVC in our data analysis. Our formative indicators generally performed well in the proposed nomological network in terms of both construct validity and predictive validity. Thus, we have developed a measure that appears to be a useful tool to gauge individual IVC. However, within the sample group used for testing this construct, two dimensions of IVC were not significant—CSE and VSS. We speculate that this could partly be a func-

tion of our respondent group. Since the group represented contemporary knowledge workers across a wide variety of reasonably senior positions and with an average age of 41 years (Gen X age group), it may be that they all possessed a baseline level of CSE (mean = 5.24, standard deviation [SD] = 1.16), which renders it a less salient component of IVC for this sample [81]. Further, our participants have all received business school training, and social skills were a major component of their education. As a result, respondents might have achieved a comfortable level of social skill (mean = 4.44, SD = 1.16) that enables them to manage social interactions in a variety of situations. They are likely to be able to build congenial relationships in virtual settings because of their acquired understandings of social interactions in general. This may lessen the salience of VSS for them and make VSS appear insignificant in our respondent group. Alternatively, it could be that there was not enough variance in CSE and VSS such that the analysis we used, PLS, did not have enough variance in order to produce reliable estimations of relationships between the constructs in question. However, the standard deviations of these constructs suggest otherwise, supporting our speculation that these two dimensions of virtual competence were not mobilized by our respondents in their work.

Nevertheless, the weights and the significance of the dimensions of a second-order construct are context specific [19]. The theoretical basis of the inclusion of the dimensions of IVC is sound, rooted as it is in prior research. Even though the results of this study provide evidence for this construct and support some of the dimensions, we feel that it is still early to draw definitive conclusions about which dimensions to keep or drop in future work, especially when the focal phenomenon, virtual work, is very diverse and still evolving (e.g., [22, 47]). Defining competence is an iterative process requiring multiple tests [82]. Therefore, we believe that in the short term, it is important to retain all the dimensions of IVC to test various boundary conditions and refine the IVC measure over multiple tests, multiple sample groups, and in multiple contexts (e.g., [75]). Dropping the nonsignificant dimensions now would limit future researchers' ability to fully capture competence in various virtual settings, limiting the generalizability of this construct and providing a problematic foundation for future research to draw upon. Below we suggest future research that would enable a fuller testing of IVC across contexts and respondent groups so that firmer measurement conclusions can be drawn over time.

Among the dimensions of IVC, VMS appears to be the most important in our sample, as demonstrated by the highest weight of it among all the dimensions (see Table 3). A follow-up *t*-test also revealed that the weight of VMS was significantly greater than the other significant weight of RWSE ($t = 31.08$, $p < 0.001$). Indeed, virtual work has been criticized for presenting an environment in which interpersonal communication is ineffective [26, 42, 73]. We believe that part of the explanation for such criticism is that virtual work is still a relatively new phenomenon and people exhibit varying degrees of skill at communicating via ICTs [47, 80]. In this situation, the capability to leverage ICTs to effectively and efficiently communicate becomes critical because computer-mediated communication is the very basis of virtual work [73]. Our results reflect the importance of this capability.

In addition to showing the effects of IVC, our results also shed light on the mechanisms by which individuals obtain this critical capability. Drawing on social cognitive theory [5], we proposed that individuals develop IVC from previous experiences during various activities in both their workplace and daily life. Consistently, our analysis shows positive relationships between experiences with virtual settings and IVC. Individuals who are more experienced with virtual settings show higher IVC and consequently better work outcomes.

Interestingly, virtual daily life experience has as much predictive power as virtual work experience. As shown in Figure 3, the standardized coefficient of virtual daily life experience is only slightly smaller than the standardized coefficient of virtual work experience. We conducted a paired *t*-test to determine the significance level of the difference and it appeared to be nonsignificant ($t = 1.325$, $p = 0.186$), suggesting that the two antecedents are equally important in determining IVC. This finding echoes the notion of the virtualization of our society [17] and provides a foundation for exploring in greater depth how use of newer daily life technologies (Facebook, Twitter, etc.) transfers into the workplace. Given technology's ubiquity, individuals are exposed to many technologies outside their work (e.g., social media), which provides more opportunities to learn and practice how to work with them [38]. It is not surprising to see virtual daily life experience having an impact on IVC, a capability that transcends workplace contexts. In addition, the level of virtual daily life experience is still low in our sample (a mean of 3.86 on a seven-point scale), potentially because ICTs were first adopted in workplaces and then spread to daily life and because older workers appear to adopt daily life technologies (e.g., Facebook) less widely than the younger generation (millennials), although this is changing [81]. Given the already high exposure to virtual activities in work settings, there could be more increase in IVC from virtual daily life experience—and this represents a fruitful avenue for our future research.

With communication being the only significant subdimension of virtual daily life, it seems that our respondents used ICTs, such as the Internet, mostly for communicating with others outside the workplace. Without further investigation, it is unclear what could be the determinants of this observation. Nevertheless, one explanation might be related to the relatively low level of use of ICTs in daily life, as discussed above. When sporadically used (a couple of times a month according to our scale), ICTs are likely to be used for the most fundamental purpose, which is communication in virtual daily life [37], as their potentials are yet to be perceived [14]. Also, the majority of our respondents were men in their mid-career; men have been found to use ICTs more for communication than other uses, compared to other groups such as the ones with more younger workers [81]. As such, the experience with communication might carry a lot of weight in the overall virtual daily life experience in our sample. These possibilities suggest that there is room to improve IVC through virtual daily life experience, through both increased and diversified exposure.

The results of this study have to be interpreted in light of its limitations. As with any survey-based study, our work is subject to common methods bias [70]. When we asked

participants about their capabilities and perceived performance in one questionnaire, their answers to these questions might be correlated due to the tendency of individuals to avoid dissonance. Given the exploratory nature of our study, we recognize this bias, but we also believe that the survey method was an effective, broadly accepted starting point (e.g., [85]), which further research can build upon. In addition, the self-reported measures used may also introduce social desirability bias—people may overestimate their competence or performance to make themselves look good [34]. Following examples in prior studies on competence, we worded our survey items carefully to minimize social desirability bias. We believe the results demonstrate that this bias is not worrisome with our data. For instance, the values of VSS range from 1.2 to 7, with a mean of 4.44 and a standard deviation of 1.16, showing a distribution that covers both the low and high ends of the scale with a considerable amount of variance. Nevertheless, future research that employs multiple methods, such as observations or objective measures, would certainly help verify the findings of this study and contribute to a clearer understanding.

Another limitation is that only 16 percent of the variance in virtual competence is explained by the model, which suggests that a productive stream of future research would be to explore the antecedents of IVC. We have demonstrated that experiences with virtual settings help develop virtual competence. Nevertheless, it is not clear yet how the type of virtual work or online activities would affect the development of specific dimensions of virtual competence. In addition, while experience provides an informal mechanism to develop IVC, there are other contributors. One of them could be formal training, which has been argued to be able to enhance individual awareness and competence in virtual settings considerably (e.g., [16]). Because the purpose of our model was to demonstrate the nomological validity of IVC, we did not exhaust all of the possible antecedents of IVC, but chose experiences in line with our overall theory—social cognitive theory. However, it is certainly a promising direction to explore more antecedents of IVC in future research to enhance the understanding of how it is developed.

Last, competence is not a static trait of individuals—it may change across settings; therefore, defining it is an iterative process [82] that our, and hopefully others', future research will continue to explore. Drawing on various theories, findings, and prior conceptualizations of competence in the IS field, we have identified virtual self-efficacy, VMS, and VSS as the components of IVC. Although we believe they capture the key capacities in virtual settings, future research is needed to test our conceptualization and explore additional elements of individual competence in different and more specific virtual settings. For example, some virtual work settings are designed to involve global teams with members from different cultures [39, 41, 46]. In those contexts, cross-cultural knowledge and skills, such as understanding differences between cultures and being able to cope with these differences, are likely to be crucial. We believe that a fruitful area of future research would be to examine whether a separate IVC dimension pertaining to cross-cultural skills is needed in cross-cultural contexts in order to further enrich our understanding of competence in virtual settings.

Conclusions and Implications

In this study, we proposed a new construct to capture the key KSAs of individuals in virtual settings. We theoretically defined IVC and empirically developed its measures in a nomological network. Our results supported the positive effect of IVC on individual work outcomes in virtual settings and revealed the experiences with virtual work and online daily life as two significant antecedents of IVC. We concluded that IVC is an important individual characteristic that determines individual work outcomes in virtual settings.

As an initial step toward defining and specifying a role for IVC, we believe our work contributes to theory by filling the void of individual KSAs in virtual settings. Prior studies have mainly relied on group-level and firm-level factors to study the effectiveness of virtual organizations (e.g., [39, 58, 91]). We complement prior research by highlighting individuals and the role they perform in effective work performance regardless of the degree of virtuality present. Drawing on a general framework of competence at work, prior conceptualizations of competence, and existing findings in the virtual work literature, we identify the key capabilities individuals need in virtual settings. Virtual self-efficacy, VMS, and VSS capture the self-concept, skill, and knowledge aspects of IVC and provide insights into the individual KSAs in virtual settings.

Our theorizing of IVC expands the understanding of individual competence in the IS literature. First, prior research on individual competence mainly discusses the knowledge and skill dimensions of competence. For instance, IT competence is defined as the knowledge about and experience with IT [9]. Drawing on a broader framework [82], this study stresses self-efficacy as a component of competence, and thus enriches the understanding of competence as a multidimensional construct (e.g., [57]). Second, IVC reflects a different orientation from prior conceptualizations of competence in the IS literature; it stresses the competence in coping with an IT-enabled environment rather than IT itself. Such an orientation shifts focus from IT-related practices (e.g., the use of end-user technologies [60]) to work practices in general, allowing us to make inferences about individuals' work outcomes beyond IT. This orientation presents an environment-based view of competence and an effective alternative approach to theorizing about individual competence. Furthermore, our findings about the effects of virtual competence (with its three dimensions) provide a concrete and specific embodiment of the general idea of individual competence, adding one more piece to the understanding of what specific competencies are needed for individuals to perform well in contemporary work settings.

We also contribute to the IS literature by providing measures of IVC. Tested in a nomological network, the measures of IVC show satisfactory reliability, convergent validity, discriminant validity, and predictive validity. Researchers can include IVC in their models to study various phenomena regarding individuals in virtual settings. For instance, IVC could be included in the research on trust in virtual settings. Research has highlighted interpersonal trust as an important factor that influences virtual team effectiveness [13, 41, 64, 68]. IVC could be included as an antecedent of trust because

it taps into an individual's capability to communicate and interact socially with others in virtual settings, and we expect this capability to facilitate the kinds of virtual social interactions that foster trust. Therefore, the current study provides a useful instrument for future research.

From a managerial perspective, we have identified the effects of IVC on individual work outcomes (i.e., satisfaction and perceived performance), which can guide managers to improve virtual work effectiveness. Prior research has advised on work setup, the dynamics among individuals, the characteristics of technology, management policies, and so forth (e.g., [3, 46, 64]). Our research shows that investments in individuals themselves are beneficial, too. Although this is not news, this message does present a mind-set shift to managers in managing virtual settings and the increasing virtuality of much work. Beyond the already substantial investments in technology and coordination (e.g., traveling, team building), it is worthwhile to take individuals' capabilities into consideration, as they affect how other efforts translate to performance [57]. Managers could encourage individuals to experience a broad array of technology and applications as an avenue toward enhancing IVC at work.

More practically, the results may be used to design and facilitate training. Virtual work challenges traditional skill sets, resulting in a demand for training and personal development [16]. IVC provides managers with a lens to look into what needs to be improved. Managers can use the measures of IVC to gauge employees' capabilities in virtual work, identify weaknesses, and develop training plans accordingly. While training could be conducted in a variety of ways, training programs targeted at improving individual capabilities in this kind of work may be more effective when delivered online. In this case, individuals would be able to benefit from not only the content of training but also the format through learning by doing in a virtual environment. In addition, outside of formal training, managers can also monitor the virtual work capabilities exhibited by employees on a regular basis and look for opportunities to provide everyday work experiences that help develop these capabilities.

Moreover, managers can make hiring decisions based on individuals' levels of IVC and experiences with virtual work and online daily life. We have shown that individuals who have more experiences are more competent and therefore may achieve better work outcomes in virtual settings. Hence, individuals with higher levels of IVC are good candidates for hiring because they are likely to be high performers. The scales we developed could be used as part of the preemployment assessment to assist recruiting managers in identifying such candidates. Alternatively, under circumstances where a thorough assessment is unfeasible, prior experiences with virtual work and online daily life could be used as indicators given the positive relationship between them and IVC. A quick look at virtual work experience on a resume or a simple question about the frequency of activities in virtual environments would give recruiting managers some sense of the potential of a candidate. These suggestions could help managers optimize their workforce and improve the overall effectiveness of virtual work.

Finally, our research reveals that nonwork use of ICTs can actually be beneficial in the workplace. Regardless of the context, individuals gain confidence, knowledge, and skills during the use of ICTs. These acquired capabilities in turn influence their

use of ICTs and potentially their performance at work [38]. Therefore, organizations should consider this potentially positive aspect of nonwork ICT use and investigate whether harnessing such activity might be more beneficial than prohibiting it. This notion is in line with some of the emerging ideas in the practitioner literature that suggest that introducing online games and virtual worlds actively in the workplace might in fact improve employees' engagement and efficiency [76]. Thus, rather than banning personal applications such as Facebook and Second Life, perhaps managers should examine the value of such applications in helping employees develop transferable skills that would benefit their virtual work.

Notes

1. When examining reflective measures, we dropped one item that was to measure performance (PER1) and one item that was to measure RWSE (RWSE1). This is because of very poor loadings (< 0.7) on their corresponding constructs, which suggests that errors explain more than half of the variance in them [6, 15]. They do not effectively reflect their corresponding constructs.

When examining formative measures, we dropped one item that was to measure variety of practice (VAR1) due to severe multicollinearity.

2. A table of item loadings and cross-loadings supporting these conclusions is available from the first author on request.

3. Another possible reason for the nonsignificant weights is multicollinearity. We calculated variance inflation factors (VIFs) to detect potential multicollinearity. The highest VIF was 2. Compared to 10 as the threshold for serious multicollinearity [61], the results indicated that multicollinearity was not an issue with the data.

References

1. A world of connections: Online social networks are changing the way people communicate, work and play, and mostly for the better, says Martin Giles. *Economist,* January 28, 2010 (available at www.economist.com/specialreports/displaystory.cfm?story_id=15351002/).

2. Ahuja, M.K., and Galvin, J.E. Socialization in virtual groups. *Journal of Management, 29,* 2 (April 2003), 161–185.

3. Ahuja, M.K.; Galletta, D.F.; and Carley, K.M. Individual centrality and performance in virtual R&D groups: An empirical study. *Management Science, 49,* 1 (January 2003), 21–38.

4. Anderson, J.C., and Gerbing, D.W. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103,* 3 (1988), 411–423.

5. Bandura, A. *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice Hall, 1986.

6. Barclay, D.; Higgins, C.; and Thompson, R. The partial least squares (PLS) approach to causal modeling: Personal computer adoption and use as an illustration. *Technology Studies, 2,* 2 (1995), 285–309.

7. Bargh, J.A., and McKenna, K.Y.A. The Internet and social life. *Annual Review of Psychology, 55* (February 2004), 573–590.

8. Bassellier, G., and Benbasat, I. Business competence of information technology professionals: Conceptual development and influence on IT–business partnerships. *MIS Quarterly, 28,* 4 (December 2004), 673–694.

9. Bassellier, G.; Benbasat, I.; and Reich, B.H. The influence of business managers' IT competence on championing IT. *Information Systems Research, 14,* 4 (December 2003), 317–336.

10. Bock, G.-W.; Zmud, R.W.; Kim, Y.-G.; and Lee, J.-N. Behavioral intention formation in knowledge sharing: Examining the roles of extrinsic motivators, social-psychological forces, and organizational climate. *MIS Quarterly, 29,* 1 (March 2005), 87–111.

11. Bollen, K.A. Multiple indicators: Internal consistency or no necessary relationship? *Quality and Quantity, 18,* 4 (August 1984), 377–385.

12. Bono, J., and Judge, T. Core self-evaluations: A review of the trait and its role in job satisfaction and job performance. *European Journal of Personality, 17,* 2 (March 2003), S5–S18.

13. Brown, H.G.; Poole, M.S.; and Rodgers, T.L. Interpersonal traits, complementarity, and trust in virtual collaboration. *Journal of Management Information Systems, 20,* 4 (Spring 2004), 115–137.

14. Carlson, J.R., and Zmud, R.W. Channel expansion theory and the experiential nature of media richness perceptions. *Academy of Management Journal, 42,* 2 (April 1999), 153–170.

15. Carmines, E.G., and Zeller, R.A. *Reliability and Validity Assessment.* Beverly Hills, CA: Sage, 1979.

16. Chen, F.; Sager, J.; Corbitt, G.; and Gardiner, S.C. Incorporating virtual teamwork training into MIS curricula. *Journal of Information Systems Education, 19,* 1 (April 2008), 29–41.

17. Chidambaram, L., and Zigurs, I. *Our Virtual World: The Transformation of Work, Play and Life via Technology.* Hershey, PA: Idea Group, 2001.

18. Chin, W.W. The partial least squares approach to structural equation modeling. In G.A. Marcoulides (ed.), *Modern Methods for Business Research.* Mahwah, NJ: Lawrence Erlbaum, 1998, pp. 295–336.

19. Chin, W.W., and Gopal, A. Adoption intention in GSS: Relative importance of beliefs. *DATA BASE for Advances in Information Systems, 26,* 2–3 (May–August 1995), 42–64.

20. Chin, W.W., and Newsted, P.R. Structural equation modeling analysis with small samples using partial least squares. In R. Hoyle (ed.), *Statistical Strategies for Small Sample Research.* Thousand Oaks, CA: Sage, 1999, pp. 307–341.

21. Chin, W.W.; Marcolin, B.L.; and Newsted, P.R. A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research, 14,* 2 (June 2003), 189–217.

22. Chudoba, K.M.; Wynn, E.; Lu, M.; and Watson-Manheim, M.B. How virtual are we? Measuring virtuality and understanding its impact in a global organization. *Information Systems Journal, 15,* 4 (October 2005), 279–306.

23. Cohen, P.; Cohen, J.; Teresi, J.; Marchi, M.; and Velez, C.N. Problems in the measurement of latent variables in structural equations causal models. *Applied Psychological Measurement, 14,* 2 (June 1990), 183–196.

24. Compeau, D.R., and Higgins, C.A. Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly, 19,* 2 (June 1995), 189–211.

25. Couper, M.P. Web surveys: A review of issues and approaches. *Public Opinion Quarterly, 64,* 4 (Winter 2000), 464–494.

26. Cramton, C.D. The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science, 12,* 3 (May–June 2001), 346–371.

27. Cronbach, L.J., and Meehl, P.E. Construct validity in psychological tests. *Psychological Bulletin, 52,* 4 (July 1955), 281–302.

28. DeRosa, D.M.; Hantula, D.A.; Kock, N.; and D'Arcy, J. Trust and leadership in virtual teamwork: A media naturalness perspective. *Human Resource Management, 43,* 2–3 (Summer–Fall 2004), 219–232.

29. Dillman, D.A. *Mail and Internet Surveys: The Tailored Design Method.* New York: John Wiley, 2000.

30. Eastin, M., and LaRose, R. Internet self-efficacy and the psychology of the digital divide. *Journal of Computer-Mediated Communication, 6,* 1 (September 2000), 25–56.

31. Ferris, G.R.; Witt, L.A.; and Hochwarter, W.A. Interaction of social skill and general mental ability on job performance and salary. *Journal of Applied Psychology, 86,* 6 (December 2001), 1075–1082.

32. Fornell, C., and Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18,* 1 (February 1981), 39–50.

33. Fuller, M.A.; Hardin, A.M.; and Davison, R.M. Efficacy in technology-mediated distributed teams. *Journal of Management Information Systems, 23,* 3 (Winter 2006–7), 209–235.

34. Ganster, D.; Hennessey, H.; and Luthans, F. Social desirability response effects: Three alternative models. *Academy of Management Journal, 26,* 2 (June 1983), 321–331.

35. Gibson, C.B., and Gibbs, J.L. Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. *Administrative Science Quarterly, 51,* 3 (September 2006), 451–495.

36. Haythornthwaite, C.; Wellman, B.; and Garton, L. Work and community via computer-mediated communication. In J. Gackenbach (ed.), *Psychology and the Internet: Intrapersonal, Interpersonal, and Transpersonal Implications.* San Diego: Academic Press, 1998, pp. 199–226.

37. Hoffman, D.L.; Novak, T.P.; and Venkatesh, A. Has the Internet become indispensable? *Communications of the ACM, 47,* 7 (July 2004), 37–42.

38. Hong, S.-J., and Tam, K.Y. Understanding the adoption of multipurpose information appliances: The case of mobile data services. *Information Systems Research, 17,* 2 (June 2006), 162–179.

39. Jarvenpaa, S.L., and Leidner, D.E. Communication and trust in global virtual teams. *Organization Science, 10,* 6 (November–December 1999), 791–815.

40. Jarvenpaa, S.L.; Knoll, K.; and Leidner, D.E. Is anybody out there? Antecedents of trust in global virtual teams. *Journal of Management Information Systems, 14,* 4 (Spring 1998), 29–64.

41. Jarvenpaa, S.L.; Shaw, T.R.; and Staples, D.S. Toward contextualized theories of trust: The role of trust in global virtual teams. *Information Systems Research, 15,* 3 (September 2004), 250–267.

42. Johansson, C.; Dittrich, Y.; and Juustila, A. Software engineering across boundaries: Student project in distributed collaboration. *IEEE Transactions on Professional Communication, 42,* 4 (December 1999), 286–296.

43. Judge, T.A., and Bono, J.E. Relationship of core self-evaluation traits—self-esteem, generalized self-efficacy, locus of control, and emotional stability—with job satisfaction and job performance: A meta-analysis. *Journal of Applied Psychology, 86,* 1 (February 2001), 80–92.

44. Judge, T.A.; Locke, E.A.; and Durham, C.C. The dispositional causes of job satisfaction: A core evaluations approach. *Research in Organizational Behavior, 19* (1997), 151–188.

45. Judge, T.A.; Locke, E.A.; Durham, C.C.; and Kluger, A.N. Dispositional effects on job and life satisfaction: The role of core evaluations. *Journal of Applied Psychology, 83,* 1 (February 1998), 17–34.

46. Kankanhalli, A.; Tan, B.C.Y.; and Wei, K.-K. Conflict and performance in global virtual teams. *Journal of Management Information Systems, 23,* 3 (Winter 2006–7), 237–274.

47. Kock, N. The psychobiological model: Towards a new theory of computer-mediated communication based on Darwinian evolution. *Organization Science, 15,* 3 (May–June 2004), 327–348.

48. Kollmann, T.; Häsel, M.; and Breugst, N. Competence of IT professionals in e-business venture teams: The effect of experience and expertise on preference structure. *Journal of Management Information Systems, 25,* 4 (Spring 2009), 51–79.

49. Kraiger, K.; Ford, J.K.; and Salas, E. Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology, 78,* 2 (April 1993), 311–328.

50. Larsen, K.R.T., and McInerney, C.R. Preparing to work in the virtual organization. *Information & Management, 39,* 6 (May 2002), 445–456.

51. Larsen, T.J. Middle managers' contribution to implemented information technology innovation. *Journal of Management Information Systems, 10,* 2 (Fall 1993), 155–176.

52. Law, K.S.; Wong, C.-S.; and Mobley, W.H. Toward a taxonomy of multidimensional constructs. *Academy of Management Review, 23,* 4 (October 1998), 741–755.

53. Lee, A.S. Electronic mail as a medium for rich communication: An empirical investigation using hermeneutic interpretation. *MIS Quarterly, 18,* 2 (June 1994), 143–157.

54. Locke, E.A. The nature and causes of job satisfaction. In M.D. Dunnette (ed.), *Handbook of Industrial and Organizational Psychology.* New York: John Wiley, 1976, pp. 1297–1349.

55. MacKenzie, S.; Podsakoff, P.; and Jarvis, C. The problem of measurement model misspecification in behavioral and organizational research and some recommended solutions. *Journal of Applied Psychology, 90,* 4 (July 2005), 710–730.

56. Majchrzak, A.; Malhotra, A.; and John, R. Perceived individual collaboration know-how development through information technology–enabled contextualization: Evidence from distributed teams. *Information Systems Research, 16,* 1 (March 2005), 9–27.

57. Marcolin, B.L.; Compeau, D.R.; Munro, M.C.; and Huff, S.L. Assessing user competence: Conceptualization and measurement. *Information Systems Research, 11,* 1 (March 2000), 37–60.

58. Mark, G. Meeting current challenges for virtually collocated teams: Participation, culture, and integration. In L. Chidambaram and I. Zigurs (eds.), *Our Virtual World: The Transformation of Work, Play and Life via Technology.* Hershey, PA: Idea Group, 2001, pp. 74–93.

59. Martins, L.L.; Gilson, L.L.; and Maynard, M.T. Virtual teams: What do we know and where do we go from here? *Journal of Management, 30,* 6 (December 2004), 805–835.

60. Munro, M.C.; Huff, S.L.; Marcolin, B.L.; and Compeau, D.R. Understanding and measuring user competence. *Information & Management, 33,* 1 (November 1997), 45–57.

61. Myers, R.H. *Classical and Modern Regression with Applications.* Boston: PWS and Kent, 1990.

62. Nunnally, J.C. *Psychometric Theory*. New York: McGraw-Hill, 1978.

63. Parks, M.R., and Floyd, K. Making friends in cyberspace. *Journal of Communication, 46,* 1 (Winter 1996), 80–97.

64. Paul, D.L., and McDaniel, R.R., Jr. A field study of the effect of interpersonal trust on virtual collaborative relationship performance. *MIS Quarterly, 28,* 2 (June 2004), 183–227.

65. Paul, S.; Seetharaman, P.; Samarah, I.; and Mykytyn, P.P. Impact of heterogeneity and collaborative conflict management style on the performance of synchronous global virtual teams. *Information & Management, 41,* 3 (January 2004), 303–321.

66. Pauleen, D.J., and Yoong, P. Relationship building and the use of ICT in boundary-crossing virtual teams: A facilitator's perspective. *Journal of Information Technology, 16,* 4 (December 2001), 205–220.

67. Petter, S.; Straub, D.; and Rai, A. Specifying formative constructs in information systems research. *MIS Quarterly, 31,* 4 (December 2007), 623–656.

68. Piccoli, G., and Ives, B. Trust and the unintended effects of behavior control in virtual teams. *MIS Quarterly, 27,* 3 (September 2003), 365–395.

69. Piccoli, G.; Ahmad, R.; and Ives, B. Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skills training. *MIS Quarterly, 25,* 4 (December 2001), 401–426.

70. Podsakoff, P.M.; MacKenzie, S.B.; Lee, J.Y.; and Podsakoff, N.P. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88,* 5 (October 2003), 879–903.

71. Poole, M.S.; Holmes, M.; and DeSanctis, G. Conflict management in a computer-supported meeting environment. *Management Science, 37,* 8 (August 1991), 926–953.

72. Porter, C.E., and Donthu, N. Cultivating trust and harvesting value in virtual communities. *Management Science, 54,* 1 (January 2008), 113–128.

73. Powell, A.; Piccoli, G.; and Ives, B. Virtual teams: A review of current literature and directions for future research. *DATA BASE for Advances in Information Systems, 35,* 1 (Winter 2004), 6–36.

74. Rasch, R.H., and Tosi, H.L. Factors affecting software developers' performance: An integrated approach. *MIS Quarterly, 16,* 3 (September 1992), 395–413.

75. Ravichandran, T., and Rai, A. Quality management in systems development: An organizational system perspective. *MIS Quarterly, 24,* 3 (September 2000), 381–415.

76. Reeves, B., and Read, J.L. *Total Engagement: Using Games and Virtual Worlds to Change the Way People Work and Businesses Compete.* Boston: Harvard Business School Press, 2009.

77. Repetti, R., and Cosmas, K. The quality of the social environment at work and job satisfaction. *Journal of Applied Social Psychology, 21,* 10 (May 1991), 840–854.

78. Ringle, C.M.; Wende, S.; and Will, A. SmartPLS. Institute for Industrial Economics and Organization, University of Hamburg, Germany, 2006 (available at www.smartpls.de).

79. Sandberg, J. Understanding human competence at work: An interpretative approach. *Academy of Management Journal, 43,* 1 (February 2000), 9–25.

80. Saunders, C.S. Virtual teams: Piecing together the puzzle. In R.W. Zmud (ed.), *Framing the Domain of IT Management: Projecting the Future . . . Through the Past.* Cincinnati: Pinnaflex Education Resources, 2000, pp. 29–50.

81. Schooley, C. Generational workforce strategies: Suggestions for coping. Research report, Forrester Research, Cambridge, MA, 2008.

82. Spencer, L.M., and Spencer, S.M. *Competence at Work: Models for Superior Performance.* New York: Wiley, 1993.

83. Stafford, T.F., and Gonier, D. What Americans like about being online. *Communications of the ACM, 47,* 11 (November 2004), 107–112.

84. Staples, D.S. A study of remote workers and their differences from non-remote workers. *Journal of End User Computing, 13,* 2 (April–June 2001), 3–14.

85. Staples, D.S.; Hulland, J.S.; and Higgins, C.A. A self-efficacy theory explanation for the management of remote workers in virtual organizations. *Organization Science, 10,* 6 (November–December 1999), 758–776.

86. Tan, B.C.Y.; Wei, K.-K.; Huang, W.W.; and Ng, G.-N. A dialogue technique to enhance electronic communication in virtual teams. *IEEE Transactions on Professional Communication, 43,* 2 (June 2000), 153–165.

87. Teo, T.S.H. Demographic and motivation variables associated with Internet usage activities. *Internet Research, 11,* 2 (May 2001), 125–137.

88. Thomas, D.M., and Bostrom, R.P. Vital signs for virtual teams: An empirically developed trigger model for technology adaptation interventions. *MIS Quarterly, 34,* 1 (March 2010), 115–142.

89. Thornton, G.C. Psychometric properties of self-appraisals of job performance. *Personnel Psychology, 33,* 2 (Summer 1980), 263–271.

90. Townsend, A.M.; DeMarie, S.M.; and Hendrickson, A.R. Virtual teams: Technology and the workplace of the future. *Academy of Management Executive, 12,* 3 (August 1998), 17–29.

91. Vakola, M., and Wilson, I.E. The challenge of virtual organisation: Critical success factors in dealing with constant change. *Team Performance Management, 10,* 5–6 (November 2004), 112–120.

92. Wang, Y., and Haggerty, N. Knowledge transfer in virtual settings: The role of individual virtual competency. *Information Systems Journal, 19,* 6 (November 2009), 571–593.

93. Warkentin, M., and Beranek, P.M. Training to improve virtual team communication. *Information Systems Journal, 9,* 4 (October 1999), 271–289.

94. Webster, J., and Trevino, L.K. Rational and social theories as complementary explanations of communication media choices: Two policy-capturing studies. *Academy of Management Journal, 38,* 6 (December 1995), 1544–1572.

95. Wellman, B.; Salaff, J.; Dimitrova, D.; Garton, L.; Gulia, M.; and Haythornthwaite, C. Computer networks as social networks: Collaborative work, telework, and virtual community. *Annual Review of Sociology, 22,* 1 (August 1996), 213–238.

Appendix A. Representative Supporting Studies for the Dimensions of Individual Virtual Competence

Dimension	Representative supporting studies	Synthesis of research findings supporting IVC link
Virtual self-efficacy	[24, 30, 33, 57, 69, 85]	Studies of remote work and virtual work, technology use at work, and learning in virtual settings confirm the importance of self-confidence as a key motivational belief that enables capable performance, thus supporting inclusion in IVC.
Virtual social skill	[2, 13, 64, 66, 72, 88, 95]	Studies about the role of trust, relationship building, socialization, and social networks within virtual contexts confirm the significant role that a social skills capability in individuals plays in enhancing various virtual work outcomes. Research has also suggested that lack of social skills contributes to loss of trust, weak relationships, and emergent risks in virtual team interaction. This supported our inclusion of virtual social skills in IVC.
Virtual media skill	[28, 39, 47, 50, 86, 88, 93]	Studies of trust and leadership, media naturalness, computer-mediated communication effectiveness, and working in virtual organizations indicate the importance of capable individual performance with media features in order to communicate and share information. Further, recent research indicates that team dysfunction can emerge as individuals improperly use or do not use the ICT tools provided. This body of research supported our inclusion of virtual media skill in IVC.

Appendix B. Survey Instrument

Computer Self-Efficacy (CSE) [24], Reflective

Seven-point scale (1 = "not at all confident," 4 = "moderately confident," 7 = "totally confident")

CSE1	I could complete my job using a new software package if I had never used one like this before.
CSE2	I could complete my job using a new software package if there is no one around to tell me what to do as I go.
CSE3	I could complete my job using a new software package if I had only the manuals for reference.
CSE4	I could complete my job using a new software package if I could call someone for help if I got stuck.
CSE5	I could complete my job using a new software package if I had seen someone else using it before trying it myself.

Remote Working Self-Efficacy (RWSE) [85], Reflective

Scales for RWSE, VSS, PER, and SAT are based on a seven-point scale (1 = "strongly disagree," 7 = "strongly agree)

RWSE1	I have confidence that I can complete my virtual work because I can access appropriate support staff readily.
RWSE2	I have confidence that I can complete my virtual work because I can access information needed to perform my job.
RWSE3	I have confidence that I can complete my virtual work because I can set objectives that align with the organization's goals.
RWSE4	I have confidence that I can complete my virtual work because I can prioritize tasks to use my time effectively.

Virtual Social Skill (VSS) [31], Reflective

VSS1	In virtual settings, I am keenly aware of how I am perceived by others.
VSS2	In virtual settings, I am good at making myself visible with influential people in my organization.
VSS3	In virtual settings, I find it is simple to put myself in other people's positions to understand their point of view.
VSS4	In virtual settings, I always know what to say to others in social situations.
VSS5	In virtual settings, I am particularly good at sensing the motivations and hidden agendas of others.

Outcomes of IVC: Performance (PER) [85] and Job Satisfaction (SAT) [84], Reflective

PER01	My manager rates the efficiency of my work highly.
PER02	I work very efficiently.
PER03	I am an effective employee.
PER04	Among my work group, I would rate my performance in the top quarter.
PER05	I am a highly productive employee.
PER06	The quality of my work output is outstanding.
SAT1	I am satisfied with the attention paid to the suggestions I make.
SAT2	I am satisfied with the relations between management and employees in my firm.
SAT3	I am satisfied with the amount of responsibility I am given.
SAT4	I am satisfied with my immediate boss.
SAT5	I am satisfied with the way I am managed.
SAT6	I am satisfied with the recognition I get for good work.

Virtual Media Skill (VMS) [94], Formative

Media types: telephone, e-mail, videoconference, instant messaging, online forum, group support systems (e.g., Intranet, Lotus Notes, and Sharepoint); seven-point scale (1 = "extremely incapable," 7 = "extremely capable")

1. To what extent do you feel you are capable of using [Media Type] to give and receive timely feedbacks when communicating with others whom you are not able to meet in person? (VMS1, VMS5, VMS9, VMS13, VMS17, VMS21)
2. To what extent do you feel you are capable of using [Media Type] to convey multiple types of information (e.g., factual information, emotional information) when communicating with others whom you are not able to meet in person? (VMS2, VMS6, VMS10, VMS14, VMS18, VMS22)
3. To what extent do you feel you are capable of [Media Type] to transmit varied symbols (e.g., words, numbers, and pictures) when communicating with others whom you are not able to meet in person? (VMS3, VMS7, VMS11, VMS15, VMS19, VMS23)
4. To what extent do you feel you are capable of tailoring the message to fit other parties' requirements when [Media Type] communicating with people whom you are not able to meet in person? (VMS4, VMS8, VMS12, VMS16, VMS20, VMS24)

Virtual Daily Life Experience (VDLE), Formative Second Order

Activities: information seeking, communication, socialization. Each is formative first order. Items: frequency (INFOR1, COM1, SOC1); seven-point (1 = "never,"

7 = "several times a day"). Items: daily usage (INFOR2, COM2, SOC2) [87]; seven-point scale (1 = "never," 7 = "more than 5 hours")

1. On the average, how frequently do you use ICT, such as the Internet, for [activity] for nonwork purposes?
2. On the average, how much time do you spend on ICT, such as the Internet, for [activity] for nonwork purposes?

Virtuality [22] Formative Second Order—Control Variable

Three dimensions: workplace mobility, team distribution, variety of practices. Each is formative first order; six-point scale (1 = "never," 6 = "daily")

Team Distribution

DIS1	Collaborate with people who speak different native languages or dialects from your own.
DIS2	Collaborate with people in different time zones.
DIS3	Collaborate with people you have never met face-to-face.
DIS4	Work with people via Internet-based conferencing applications.

Workplace Mobility

MOB1	Work at different sites.
MOB2	Work at home during normal business days.
MOB3	Have professional interactions with people outside the organization.
MOB4	Work with mobile devices.
MOB5	Work while traveling, e.g., at airports or hotels.

Variety of Practices

VAR1	Work on projects that have changing team members.
VAR2	Work with teams that have different ways to track their work.
VAR3	Work with people that use different collaboration technologies and tools.

Virtual Work Experience (VWE), Reflective, Two Dimensions—Extent and Frequency

Extent: seven-point scale (1 = "no experience," 7 = "extremely experienced"). Frequency: seven-point scale (1 = "never," 7 = "several times a day")

VWE1	How would you describe your previous experience with virtual work?
VWE2	How frequently were you involved in virtual work in the past three years?

Appendix C. The Two-Step PLS Modeling Approach

Following prior research, we adopted a two-step approach to test the proposed model because it involved second-order constructs [4, 10, 19, 21].

Step 1: Generate construct scores for the first-order constructs that constitute the second-order constructs with formative items (virtual competence, virtual daily life experience, and virtuality) and examine the measurement properties of these first-order constructs. To accomplish this step, we created a PLS model to generate the construct scores. This model resembled the proposed nomological network except that the second-order constructs were replaced by their first-order constructs respectively. The measures of each construct in this model, whether formative or reflective, were directly derived from the survey items. Construct scores of the first-order constructs were derived and merged back into the PLS data file as the formative indicators of corresponding second-order constructs.

Step 2: Examine the measurement properties of all constructs not examined in Step 1 and test the structural model. We created a second PLS model to test the hypotheses. We included the second-order constructs with the PLS-created indicators for them as shown in Figure 2. First-order constructs did not appear in this model. Their construct scores represented them as measures in the model. Measures of performance, job satisfaction, and virtual work experience remained the same as in the first model. We ran the second model and reported the results of this structural model as shown in Figure 3. We based our analysis and discussion on the second model developed in Step 2. Meanwhile, we included the information of the first-order constructs when reporting the results of the measurement model because they were the sources of the indicators of the second-order constructs and the quality of the measures of them influenced the quality of the overall measurement model.

Copyright of Journal of Management Information Systems is the property of M.E. Sharpe Inc. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.