Interaction of Individual and Social Antecedents of Learning Effectiveness: A Study in the IT Research Context

A. Kankanhalli, L. G. Pee, G. W. Tan, and S. Chhatwal

Index Terms—**Absorptive Capacity, Knowledge Sourcing Initiative, Learning Effectiveness, Learning Orientation, Social Capital**

Abstract—**Individual learning is key to performance for knowledge-intensive activities such as information technology research. Individuals' learning effectiveness is inevitably influenced by both individual differences and the social forces of their surrounding context. While learning can be arduous and the effects of both sets of factors need to be understood to facilitate it, prior studies have typically examined social and individual aspects separately. This study integrates individual factors from the symbolic cognition perspective with social factors from the situated cognition view in a model to explain learning effectiveness. The model was tested through a survey of individual learners working on information technology-related research projects. The findings indicate that the individual factors of knowledge sourcing initiative and learning orientation as well as the social factors of shared understanding and pro-sharing norms have significant influences on individuals' learning effectiveness. Further, network ties and pro-sharing norms interact with learning orientation and knowledge sourcing initiative respectively to influence learning effectiveness. Implications of these findings for research and practice are discussed.**

I. INTRODUCTION

IN knowledge-intensive environments, such as research units in information technology (IT) firms or in universities, individual learning is key to creativity and is critically linked to organizational performance [1]. Those involved in creative work such as research and development (R&D), product engineering, and information systems (IS) development must continuously learn to keep up with rapidly advancing

technology, tackle new problems, and generate innovative solutions. Individual learning influences organizational learning through shaping the organization's shared mental models [2] which in turn can lead to increased innovation [3]. Recognizing this, organizations have attempted to promote employee learning through initiatives such as designing employee training programs and implementing learning management systems [4]. However, learning can be arduous and even when employees are provided with similar opportunities to learn, their learning outcomes may differ significantly [5]. Therefore, it is important to understand how individual characteristics influence learning in organizations.

Prior research studying the effects of individual characteristics on learning often espouses the *symbolic cognition* view, which focuses on discovering and formally describing the meanings that learners create out of their encounters with the world [6]. They typically propose hypotheses about the mental activities individuals employ and meaning-making processes they use in learning [7]. In general, symbolic cognition research examines the way people absorb information from their environment, arrange it mentally, and apply it in everyday activities. This view focuses on the human mind as the locus of learning and as a consequence neglects the social context in which individual learners are embedded.

While a significant amount of work on learning underscores the role of individual attributes, research on learning in organizations increasingly highlights the importance of considering the social context (e.g., [8]). Salomon and Perkins [6] suggest that social forces can influence individual learning through a) providing the learner access to experts who can help him/her learn; b) providing opportunities for the learner to form intellectual partnerships and access to cultural artifacts such as tools and knowledge sources; and c) providing a context for the learner to participate in the social construction of meaning. For example, studies have examined the influence of the social context by analyzing how engineers learn as they interact and socialize with other engineers and gain access to relevant knowledge sources [9], [10].

The notion that social context is central to individuals' knowledge acquisition is aligned with the *situated cognition* view, which focuses on the web of social relationships within which learning takes place [11]. The perspective suggests that individuals learn as they participate in a social system, interact

Manuscript received August 19, 2009; revised February 26, 2010, September 06, 2010, January 27, 2011; accepted March 28, 2011. Review of this manuscript was arranged by Department Editor T. Ravichandran.

A. Kankanhalli is with the National University of Singapore, School of Computing, COM2 #04-16, 15 Computing Drive, Singapore 117418 (phone: +65-65164865; fax: +65-67797365; e-mail: atreyi@comp.nus.edu.sg)

L. G. Pee is with Tokyo Institute of Technology, 2-12-1-W9-120 Ookayama, Meguro-ku, Tokyo, Japan, 152-8552 (e-mail: peelg.aa@m.titech.ac.jp)

G. W. Tan is with the National University of Singapore, School of Computing, COM2 #03-39, 15 Computing Drive, Singapore 117418 (e-mail: tangw@comp.nus.edu.sg)

S. Chhatwal is with Bloom International Trading, 1005 Lower Delta Road, #11-04, Singapore 099309 (e-mail: sohrab@alumni.nus.edu.sg)

with the constituents of the system, and acquire new knowledge shaped by the system's norms [11]. The social context characterized by interactions among people, shared understanding, and norms can structure the cognitive processes through which individuals learn [12]. In general, the situated cognition perspective shifts the locus of learning process from the mind of individuals to the social sphere of interactions in which learning takes place.

While symbolic cognition research emphasizes individuals' attributes and abilities related to learning, the situated cognition perspective stresses the importance of the social setting in facilitating learning. In practice, both are likely to work in tandem [6], [12] - the learning effectiveness of individuals with favorable attributes and abilities may be significantly enhanced or hampered by the level of support of the social context in which learning takes place. Although there is valuable existing work addressing individual and social aspects of learning, few studies have integrated these aspects and examined their interrelationships empirically [13]. With the challenges of enhancing learning and the above gap in our understanding of the phenomenon, this study seeks to address the following research question: *How do social factors interact with individual factors to affect individuals' learning effectiveness*?

As will be detailed later, deriving from the symbolic cognition view, we identify absorptive capacity, knowledge sourcing initiative, and learning orientation as the potential individual antecedents of learning effectiveness. The situated cognition perspective and social capital literature suggest that key social antecedents of individuals' learning effectiveness could be network ties, shared understanding, and pro-sharing norms. These individual and social factors and their interactions are simultaneously examined in a research model to explain individual learning effectiveness. The model was empirically tested using survey data from 162 individuals conducting research projects on IT topics in a research university. The results indicate that the social factors of network ties and pro-sharing norms interact with individual factors to enhance individuals' learning effectiveness.

This study's key contribution lies in looking beyond the separate effects of individual and social factors to examine their interaction effects on individuals' learning effectiveness. As shown later, the model including interaction effects explained significant variance in learning effectiveness, improving our understanding of the phenomenon. Further, based on the theoretical perspectives of symbolic cognition, situated cognition, and social capital, key individual and social factors are identified and operationalized with measures that demonstrate satisfactory reliability and validity. For managers or supervisors, findings of this study indicate aspects of the social environment that may be nurtured to enhance individuals' learning effectiveness.

II. CONCEPTUAL BACKGROUND

In this study, the dependent variable of interest is learning effectiveness, which refers to individuals' perceived extent of learning and satisfaction with the learning process. It encompasses elements such as improvement in critical-thinking skills, ability to integrate facts, ability to identify central issues in a field, and satisfaction with the learning process [14]. Individual and social factors that may influence learning effectiveness are identified by reviewing relevant theory and literature on individual learning, as discussed next.

A. Symbolic Cognition Perspective

The symbolic cognition perspective focuses on the mental activities individuals employ in acquiring new knowledge. It highlights three aspects, namely mental representation, active epistemology, and constructivity [15]. These aspects are represented by absorptive capacity, knowledge sourcing initiative, and learning orientation respectively in our study as identified from prior research described later. We focus on individual factors that are more relevant to learning in the organizational context rather than physiological antecedents of learning (e.g., capacity of the cortical area of human brain) identified in prior symbolic cognition research [16]. This is because the objective of this study is to examine the interaction effects of individual and social factors in an institutional setting.

1) Mental Representation

The way information and knowledge are represented in the human mind may influence understanding and problem solving [17]. Learners' mental representation of their prior knowledge is one of the most commonly studied aspects of symbolic cognition [13], [18]. Knowledge acquired in the past can facilitate learning of new knowledge by suggesting linkages between new information and what has been learnt before. For example, in the development of a new technology service program, it was found that more experienced marketing research personnel are able to interpret and assimilate new market trend information more easily and incorporate them into the design of new services more rapidly [19].

Cognitive structures that encompass mental representations help to provide meaning and rationalization of past experiences, allow learners to make sense of new information, and determine their absorptive capacity [20], [21]. *Absorptive capacity* refers to individuals' ability to recognize the value of new and external knowledge, assimilate it, and apply it based on previous related experience and knowledge [20], [21]. It characterizes the cumulative mental processes through which people make sense of incoming stimuli [22]. Consistent with prior research on individual learning [23], the concept of absorptive capacity emphasizes that learning is a function of individuals' prior related knowledge. Individuals with high absorptive capacity are likely to be better able to store new knowledge into memory, associate it with existing knowledge, recall, and apply it in creative ways, resulting in more effective learning.

While absorptive capacity has often been viewed as an organization-level construct, Cohen and Levinthal [20] note that "the development of an organization's absorptive capacity will build on prior investment in the development of its

constituent, individual absorptive capacities." (p. 131) Based on the work of Szulanski [21], Griffith et al. [24] conceptualize absorptive capacity to be "individual's ability to utilize available knowledge" which "is a function of the individual's preexisting stock of knowledge." (p. 275) Recent empirical studies have also examined absorptive capacity at the individual level. For example, Deng et al. [25] found that individual engineers' absorptive capacity is positively related to their task productivity. Park et al. [26] found that individual users' absorptive capacity related to the use of enterprise resource planning systems improves their productivity, task performance, and decision effectiveness and quality. Correspondingly, this study includes absorptive capacity as a potential individual antecedent of learning effectiveness.

2) Active Epistemology

While mental representation focuses on the depiction of knowledge in a person's mind, active epistemology emphasizes the roles and behaviors the individual should undertake in the process of learning. Individuals' role in learning can be characterized along a continuum. At one end, learners are passive subjects who simply receive knowledge that is being conveyed to them (e.g., during lectures). At the other end, learners are active, intentional individuals who deem themselves primarily responsible for their own learning [27]. The extent to which an individual is active in intellectual pursuit and enthusiastically seeks knowledge from a diversity of sources such as publications, experts, and peers to learn from others' experience has been conceptualized in terms of knowledge sourcing initiative [28].

Knowledge sourcing initiative thus refers to individuals' intentional efforts to locate and access others' expertise, experience, and viewpoints. Unlike information or knowledge seeking, which includes both active and passive acquisition, knowledge sourcing initiative focuses on individuals' *proactive* efforts to search out and access knowledge [28]. Individuals with proactive dispositions identify opportunities, show interest, take action, and persevere until meaningful changes occur. They tend to harness all available resources to achieve their objectives [29]. For example, among engineers in middle management, more successful managers are found to adopt higher levels of self-learning approaches [30]. Accordingly, individuals with strong knowledge sourcing initiative may actively gather knowledge from different sources including people (e.g., subject matter experts and peers) and written materials (e.g., books and articles) for better learning outcomes.

3) Constructivity

Knowledge gathered from various sources and assimilated by relating it to preexisting knowledge may gain value when new understanding is constructed by the individual through restructuring and modification of one's schemata [22]. Constructivity describes such active pursuit to challenge existing thinking and reorganize knowledge to construct new knowledge, knowledge structures, or mental patterns. Learning orientation is a fundamental concept in research on constructivity [31]. It represents a predilection towards learning

that drives the active exertion of effort to constantly assimilate and construct new knowledge.

Learning orientation indicates individuals' predisposition to constantly construct and refine the knowledge acquired. It refers to people's desire to increase competence by developing new skills and taking up challenging tasks [31]. It suggests that learning is not just the acceptance of information and knowledge but also involves the participation of individuals in establishing meaning and structure in their intellectual pursuits. Individuals with high learning orientation tend to believe that intelligence is a malleable and controllable quality [32]. They are more persistent in the face of obstacles and are willing to adopt more complex learning mechanisms and deeper knowledge-processing strategies to overcome difficulties. They also tend to seek feedback regarding their performance and are more receptive to criticisms as these indicate ways to further improve their abilities [33].

In sum, our review of the symbolic cognition literature suggests three individual dispositional factors that may be salient to learning. First, *absorptive capacity* reflects a learner's mental representation and indicates the ability to acquire new knowledge by relating it to existing knowledge. Second, related to active epistemology, *knowledge sourcing initiative* describes the extent to which an individual actively seeks knowledge from different sources. Third, corresponding to the concept of constructivity, *learning orientation* emphasizes the role of individuals in constantly structuring their own understanding, learning, and construction of new knowledge. We will consider these three factors in our proposed model.

B. Situated Cognition Perspective and Social Capital

The effects of social factors had been neglected in prior research, which had mainly focused on the physiological and psychological aspects of learning [6]. The role of social factors in learning has also been studied separately, mostly in the fields of anthropology and sociology. However, there is growing interest in the situated cognition perspective and the importance of social factors in learning is increasingly being recognized [34]. Several studies (e.g., [35], [36]) suggest that it is essential to consider social factors in workplace learning. However, there continues to be a lack of theoretically-grounded empirical studies that consider the interactions of social and individual factors to provide a more holistic understanding.

A framework that offers a useful theoretical lens for characterizing the social relationships in an organization is that of social capital. *Social capital* includes the resources embedded within, available through, and derived from a network of relationships that individuals can access or mobilize in purposive action [37], [38]. It offers a multidimensional view of organizational social relationships that have been linked to various outcomes. For example, social capital has been found to play a key role in facilitating learning [39], cooperative actions leading to learning such as knowledge sharing [40], and R&D outcomes [41]. It supports learning by enabling individuals' access to information and knowledge through contacts, conversations, and collaborations. Three salient

dimensions of social capital (structural, cognitive, and relational) are discussed next.

1) Structural Dimension

The structural aspect of social capital describes the overall pattern of interpersonal connections through which individuals can identify others with potential resources [38]. *Network ties* constitute a fundamental aspect of structural social capital because an individual's social ties create opportunities for resource exchanges [42]. They refer to the linkages with others that are exploitable by individuals. Network ties can benefit learning through their effects on *access* to knowledge resources and the *timeliness* of such access [43]. They determine how individuals identify others with relevant knowledge resources, and how and when they can be reached. Individuals with better network ties in a social system are likely to be better able to obtain the knowledge and materials needed to support learning.

It is important to note that in this study, the concept of network ties focuses on the extent to which individuals have access to others who could be sources of knowledge rather than the extent to which the ties are actually accessed for gathering knowledge. The latter notion is considered under the construct of knowledge sourcing initiative instead. Network ties is different from knowledge sourcing initiative in that it represents the characteristics of people's social network which specify the conditions under which learning takes place. On the other hand, knowledge sourcing initiative refers to individuals' proactive behavior of reaching relevant others to obtain knowledge perceived to be valuable to their learning goals. Even when a potential knowledge source is identified, knowledge sharing may not occur if the knowledge source and learner are unable to communicate effectively (i.e., cognitive social capital) or the source lacks rapport with the learner (i.e., relational social capital), as discussed next.

2) Cognitive Dimension

In a social system, members are able to interact effectively only if they share similar cognitive structures. The cognitive component of social capital addresses the need to have shared representations, interpretations, and systems of meaning among parties in a social network [37], [38]. These can take the form of shared language and codes as well as shared narratives. The former includes the mental schemata that are used to organize information and knowledge into perceptual categories for interpretation. Shared narratives constitute rich contextual information that facilitates the exchange of tacit experience [44]. These shared assets contribute towards *shared understanding*, which represents the extent to which people's language, thinking approaches, and prior backgrounds are similar [45]. Prior research has stressed the need for individuals to develop shared understanding in interpersonal interactions to fuel knowledge sharing [46]. When people think and talk about ideas in similar ways, their level of understanding and absorption of the knowledge communicated increases and learning is likely to be enhanced [47].

3) Relational Dimension

Even with common cognitive structures, individuals may not always interact and share resources in a social system if they lack rapport with others in the system. The nature of interpersonal relationships is characterized by the relational dimension of social capital [38]. *Pro-sharing norm* is an important aspect of relational social capital that facilitates individual learning [38]. It represents the degree of consensus regarding knowledge sharing in a social system [48] and includes norms of collaboration, willingness to value diversity, and openness to conflicting views [49]. When such norms exist, people often develop relationships that encourage knowledge sharing and interpersonal learning. Also, they become more receptive to diverse views by which learning can be further enhanced through creative abrasion [50].

III. RESEARCH MODEL AND HYPOTHESES

The proposed research model is shown in Fig. 1. The model suggests that the individual attributes related to symbolic cognition (i.e., absorptive capacity, knowledge sourcing initiative, and learning orientation) and situated cognition factors conceptualized based on the social capital theory (i.e., network ties, shared understanding, and pro-sharing norms) can influence individuals' learning effectiveness. In addition, the individual and social factors are hypothesized to interact to influence learning effectiveness.
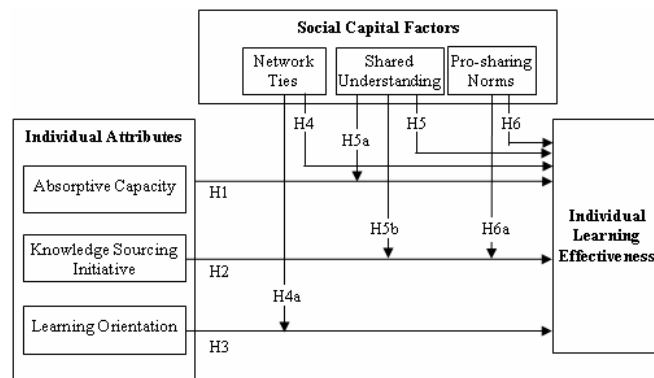

Fig. 1. Proposed Research Model

A. Absorptive Capacity

Absorptive capacity supports symbolic cognition by allowing individuals to learn by forming new conceptions based on prior knowledge [7]. Prior knowledge can include definitions of basic concepts about a topic, scientific and technological developments in fields related to the topic, and even different strategies that may be suitable for learning about the topic of interest. Existing knowledge provides individuals with the background necessary to sift through large amounts of information and knowledge related to a topic and increases their ability to store new knowledge into their memory for future recall and application [20]. Prior knowledge facilitates learning because memory is developed by associative and cumulative learning in which events are recorded into memory by establishing linkages with preexisting concepts and patterns. This reasoning concurs with existing research on human cognition which suggests that memory is self-reinforcing [51]. In other words, the more concepts and patterns are stored in

memory, the more readily are new related concepts acquired, and the more easily individuals are able to apply them in new contexts. The way in which prior knowledge is organized, their linkages and differences with other concepts, all support the sense-making process. This in turn can facilitate the acquisition of new knowledge and should result in better learning outcomes. Therefore, we hypothesize that:

H1: Individuals' absorptive capacity is positively related to learning effectiveness.

B. Knowledge Sourcing Initiative

Knowledge sourcing initiative indicates individuals' intentional and proactive effort to access others' expertise, experience, and viewpoints [28]. This initiative allows the learner to gain insights from the experience of others [52] which may exist in the form of opinions arising from dialogues with subject experts or codified knowledge in publications. Unlike learning from one's own experience, knowledge sourcing initiative exposes individuals to others' understanding and interpretation of the phenomenon of interest. Examining others' mental models constitutes a stimulus that may modify one's cognitive structures and augment learning. Knowledge sourcing initiative has been found to result in beneficial learning in several social contexts including project teams [53] and peer networks [54]. Based on these observations, we hypothesize that:

H2: Individuals' knowledge sourcing initiative is positively related to learning effectiveness.

C. Learning Orientation

Individuals' predilection in learning is likely to determine their construction of understanding and assimilation of new knowledge. Learning orientation indicates the individual's desire to improve competence by acquiring new skills and overcoming challenges [55]. The concept has often been contrasted with performance orientation, where people tend to focus on the final outcome of learning and have apprehension of failure and the consequences it entails [32]. Individuals with performance orientation tend to favor tasks that allow them to demonstrate their competence while individuals with learning orientation tend to seek challenging tasks that provide them with opportunities to learn new knowledge. The latter group perceives errors as an instructive and natural component of the learning process in which they seek to develop their capability, acquire new skills, and learn from experience. Compared to individuals with low learning orientation, people with high learning orientation are likely to gain more from their learning endeavor. Accordingly, we hypothesize that:

H3: Individuals' learning orientation is positively related to learning effectiveness.

D. Network Ties

Network ties represent the structural form of social capital [38] which determines individuals' *access* to resources in a social system and the *timeliness* of such access [43]. These ties can benefit learning through improving access to knowledge at the appropriate time. Being able to access knowledgeable others in a timely manner allows individuals to bring relevant expertise to bear on the topic to be mastered and can thereby enhance their learning effectiveness. Therefore, we hypothesize that:

H4: Individuals' network ties are positively related to learning effectiveness.

As a social factor, network ties are likely to interact with individuals' learning orientation to affect learning effectiveness. When individuals have limited network ties, they will have less access to valuable expertise or the access may not be prompt enough to satisfy their learning needs. This restricts their momentum in acquiring new skills and solving problems, even when they have high learning orientation. In contrast, when individuals have strong network ties that can be exploited to obtain needed help in time, they can learn more effectively with enriched expertise in solving problems and increased exposure to relevant skills. Therefore, we hypothesize that network ties interact with individuals' learning orientation in influencing learning effectiveness:

H4a: The positive relationship between individuals' learning orientation and learning effectiveness will be stronger when they have strong network ties.

E. Shared Understanding

Learners must be able to communicate effectively with the knowledge sources to make sense of the knowledge being offered. Shared understanding, which refers to the extent to which interacting individuals' background, language, and thinking approaches are similar [45], can help to minimize coherence gaps and ease the knowledge acquisition process [47]. When there is a high level of shared understanding with potential knowledge sources in one's network, the knowledge gathered from these sources is more readily comprehensible. Therefore, we hypothesize that:

H5: Shared understanding is positively related to learning effectiveness.

We expect shared understanding to interact with individuals' absorptive capacity to affect learning effectiveness. When there is a high level of shared understanding in terms of language, thinking approaches, and prior experience, knowledge gathered from others is more comprehensible and individuals' absorptive capacity can be better leveraged to learn about the task at hand [46]. On the other hand, when there is a low level of shared understanding, sharing of knowledge and eventually learning may be more arduous even when absorptive capacity is high. This suggests a synergistic interaction between absorptive capacity and shared understanding in influencing learning effectiveness. Hence, we hypothesize that:

H5a: The positive relationship between individuals' absorptive capacity and learning effectiveness will be stronger when there is high level of shared understanding.

The level of shared understanding can also influence the effect of individuals' knowledge sourcing initiative on learning effectiveness. When shared understanding is high, people are likely to be able to communicate with one another and understand each others' needs better. The knowledge

exchanged between knowledge sources and learners is likely to be easier to comprehend and assimilate than when shared understanding is weak [48]. With clearer understanding of the learner's knowledge needs, better recommendations of relevant knowledge sources (e.g., written materials) are also likely to be provided. These will ease learners' search effort and cognitive burden and allow them to channel their energy to learning, thereby improving their learning effectiveness. In other words, considering two learners with similar level of knowledge sourcing initiatives, the individual who has higher level of shared understanding with sources is likely to learn more effectively. Accordingly, we hypothesize:

H5b: The positive relationship between individuals' knowledge sourcing initiative and learning effectiveness will be stronger when there is high level of shared understanding.

F. Pro-sharing Norms

Pro-sharing norms represent the degree of consensus in a social system with regard to sharing and collaboration [49]. In a setting where there are strong norms of sharing knowledge and discussing diverse views openly, knowledge resources are more readily accessible and knowledge acquisition can be enhanced as individuals engage in interactions to challenge, shape, and refine their mental schemes [56]. An environment with strong norms favors knowledge exchange and is likely to result in positive learning outcomes. Hence, we hypothesize that:

H6: Pro-sharing norms are positively related to learning effectiveness.

We expect that the level of pro-sharing norms is likely to interact with the individual factor of knowledge sourcing initiative. When pro-sharing norms prevail, individuals see sharing knowledge with seekers as a common and expected behavior. They are likely to be more willing to share knowledge as well as information about relevant sources of knowledge (e.g., journal articles and books). This augments the effect of knowledge sourcing initiative on learning effectiveness as pertinent knowledge can be gathered more easily and learners can focus on the task of assimilating the knowledge rather than searching for it. In contrast, when pro-sharing norms are lacking, people are unwilling to expend extra effort to share their knowledge [57]. The search for information and knowledge may be hindered even when the learner is proactive (i.e., strong knowledge sourcing initiative). We therefore hypothesize that:

H6a: The positive relationship between individuals' knowledge sourcing initiative and learning effectiveness will be stronger when there is high level of pro-sharing norms.

G. Control Variables

Apart from the constructs identified from the symbolic cognition and situated cognition literatures, other possible influences on learning effectiveness are included in the proposed model as control variables to dismiss plausible rival hypotheses. As with prior studies, we control for the effects of learners' gender [58]. In addition, considering that our respondents are individuals learning about IT-related topics in research projects, we also include prior work experience, research experience, and project tenure at the time of survey as control variables. This is because individuals with more experience in work, research, and with the project are likely to achieve better learning outcomes.

IV. RESEARCH METHODOLOGY

Data for assessing the proposed model were collected through a survey of undergraduates conducting IT-related research projects in a research university. Such a tertiary institution is a suitable context for this study because it is a knowledge-intensive organization with substantial research activities, where continual learning is considered essential [59]. Its members also build social relationships with one another, thereby allowing us to examine the joint effects of social and individual factors on learning effectiveness.

The survey instrument was developed following a systematic process recommended by Churchill [60]. Items were adapted from existing measures as much as possible. A pilot study and sorting routine suggested by Moore and Benbasat [61] were incorporated into the process to initially verify the instrument's reliability prior to the actual survey.

A. Construct Operationalization

To ensure methodological soundness, it is important to develop measurement models that adequately represent the constructs being measured. To avoid misspecification of the measurement model, which may in turn bias the structural model [62], we clearly distinguished between reflective and formative constructs in their operationalization. *Reflective* constructs have observed indicators that are affected by an underlying latent, unobservable construct [63]. In other words, changes in the underlying construct are expected to cause changes in the indicators [62]. On the other hand, *formative* constructs are a composite of multiple indicators [64], [65]. Each indicator captures different aspects of the construct and changes in the underlying construct are caused by changes in the formative indicators [62]. In our study, knowledge sourcing initiative and network ties are formative constructs while the remaining constructs are considered reflective, as described next.

Items measuring *absorptive capacity* were developed based on its conceptual description by Cohen and Levinthal [20] and Szulanski [21]. They assess the extent to which individuals use, relate, and associate prior knowledge to facilitate the learning of new knowledge. Since the items are affected by the same underlying concept and are parallel measures that covary, the construct is considered reflective [62].

Knowledge sourcing initiative was operationalized based on the description of the concept by Gray and Meister [28]. To suit the context of this study, we considered the knowledge sources that are relevant for a research university i.e., written materials (e.g., journals), experts as represented by professors, and peers as represented by students. The items assess the extent to which an individual approaches these sources for knowledge.

Knowledge sourcing initiative is considered to be a formative construct because each of its items taps into different themes and the items are not interchangeable [62]. They are also not expected to covary e.g., it is possible for an individual to seek professors for knowledge but not peers. It has also been modeled as a formative construct in prior studies (e.g., [28]).

Learning orientation was measured by items adapted from Brett and VandeWalle [66]. They assess the extent to which individuals expend effort and take up challenges to enhance their skills. Similar to Brett and VandeWalle [66], the construct is considered to be reflective since all items have a common core and are likely to covary [62].

The operationalization of *network ties* was based on its conceptualization by Nahapiet and Ghoshal [38] and Burt [43], which highlights individuals' *access* to resources in a social system and the *timeliness* of such access. While some studies have operationalized network ties in terms of more objective measures such as closeness, frequency, duration of interaction (strength of ties), or centrality (e.g., [67]), these measures have sometimes been observed as difficult to recall and scope (e.g., how many contacts should be considered?) [68]. Thus, several studies have conceptualized network ties in terms of access and timeliness (e.g., [69], [70]). Accordingly, the construct is measured in terms of the extent to which relevant social constituents are readily accessible and knowledge from them is available on time to a learner.

In the context of this study, we consider individuals' social network ties (in terms of access and timeliness) with professors and other students. All undergraduate researchers in this study were assigned to a professor as academic supervisor in the course of their research. However, they could also approach other professors and students for their assistance on the project depending on their social networks and relationships. Although written material may be a significant source of knowledge, it is not a form of social constituent and is therefore excluded from the operationalization of network ties. Accordingly, the construct of network ties is construed as a second-order construct comprising the first-order constructs of access and timeliness. The first-order constructs of network ties are considered to be formative [62] because an individual's relationship with professors and peers may not covary (e.g., an individual may have ready access to peers but not professors).

Items measuring *shared understanding* were developed based on its conceptualization described by Nahapiet and Ghoshal [38]. They assess the extent to which an individual is able to effectively exchange ideas with potential knowledge sources (i.e., professors and peers). This is construed as a second-order construct comprising the first-order constructs of understanding with peers and with professors. The first order constructs are considered as reflective since their items are likely to covary [62].

Pro-sharing norms were measured with items adapted from Kankanhalli et al. [49]. The items assess whether there are norms of sharing, valuing and responding to diversity, openness, and tolerance. These items are affected by the same underlying concept and the construct is therefore considered to be reflective [62]. Similarly, it was analyzed as a reflective construct by Kankanhalli et al. [49].

Items measuring *learning effectiveness* were adapted from Alavi [14]. They assess improvements in an individual's critical-thinking skills, ability to integrate facts, ability to identify central issues in a field, and satisfaction with the learning process. In line with Alavi [14], the construct is considered to be reflective since the items are likely to covary. In addition, we also collected data on the actual grade students received for their projects as an objective measure of learning effectiveness.

The items measuring all constructs are listed in the Appendix. All constructs except absorptive capacity and knowledge sourcing initiative were measured with four items. All items except the actual grade were measured using seven-point Likert scales with two anchors labeled "strongly disagree" and "strongly agree". Actual grade was measured on a scale of 1-12 representing the range of letter grades from F (unsatisfactory) to A+ (excellent).

To initially assess the proposed instrument and identify any further refinement, we conducted unlabeled and labeled sorting procedures proposed by Moore and Benbasat [61]. Results indicated that both inter-judge raw agreement scores and Kappa scores averaged 0.99, and placement ratio of items within targeted constructs averaged 0.97. All results were satisfactory, suggesting that the proposed instrument is adequate. We then conducted a pilot study of a convenience sample before the actual survey, whose results also demonstrated the adequacy of the instrument.

B. Survey Administration

The targeted population of this study is individuals learning in social contexts such as organizations. Our sampling frame comprises senior undergraduates conducting research on IT-related topics in a research university. They constitute a suitable sample because the projects are often the respondents' first major tryst with formal research, thereby requiring considerable learning on their part to grasp knowledge related to their topic as well as on various research methodologies. Like R&D projects in general, creativity and contribution of new knowledge were significant aspects of these projects' outcome. In the course of research, the respondents were assigned to a professor as academic supervisor. They sometimes approached other professors and students for their assistance on the project as well. They were also provided access to knowledge resources such as books and publications in the university's library and on the Internet to learn about their topic.

We solicited participation in the survey mainly by approaching potential respondents in their research laboratories or after lecture classes. Participation in the survey was completely voluntary and was not associated with their academic grades in any manner. To ensure that the respondents have at least a basic understanding of their research topic and have had some experience obtaining knowledge from various sources, only those who had worked on their projects for more

than two months were included. A total of 164 responses were collected from which two incomplete responses were eliminated, leaving 162 usable responses for data analysis. The respondents' demographic profile is shown in Table I. Most respondents ranged in age from 20 to 24. There were about twice as many males as females. Approximately half of the respondents had prior work experience but only 13% had prior research experience. The majority had spent 2-4 months working on their project.

TABLE I
DESCRIPTIVE STATISTICS

Characteristic	Frequency	Percentage (%)
Age		
< 20	2	1.2
20 - 24	157	96.9
25 - 29	3	1.9
Gender		
Male	110	67.9
Female	52	32.1
Prior Work Experience (e.g., Internships)		
Yes	80	49.4
No	82	50.6
Prior Research Experience		
Yes	21	13.0
No	141	87.0
Project Tenure (Months)		
2 - 4	117	72.2
5 - 7	17	10.5
> 7	28	17.3

V. DATA ANALYSIS AND RESULTS

Partial Least Squares (PLS) analysis was conducted to assess the proposed research model. PLS was chosen over covariance-based techniques because mutual exclusivity among formative indicators or between indicators and constructs was not assumed in this study [64]. SmartPLS version 2.0 [71] was used to assess the measurement and structural models. All data were standardized in the analyses.

A. Tests of Measurement Model

The measurement model was assessed by examining reliability, convergent validity, and discriminant validity of the instrument items. Reflective and formative constructs need to be treated differently during assessment because, unlike reflective constructs, different dimensions of formative constructs are not expected to demonstrate internal consistency and correlation [65]. Formative constructs were assessed by examining the relevance and level of contribution of each item.

For the reflective constructs, reliability was assessed with Cronbach's alpha coefficient (see Table II). All constructs achieved scores above the recommended 0.70 [72]. Convergent validity was assessed by examining item loading, composite reliability, and average variance extracted (AVE) by each construct (see Table II). All item loadings and composite reliabilities were above the recommended level of 0.70 and all AVEs were above 0.5 [73], indicating that convergent validity of the instrument was satisfactory.

Discriminant validity was assessed by factor analysis and comparing construct correlations and square root of AVE. In

factor analysis, all items loaded highly on their stipulated constructs but not highly on other constructs (see Table III) [74]. The correlation matrix (see Table IV) shows that all the non-diagonal entries (i.e., construct correlation) did not exceed the bold diagonal entries (i.e., square root of AVE), indicating that the items of each construct correlated more highly with their own items than with items measuring other constructs [75]. The correlations ranged from 0.08 to 0.67, and the highest correlations were between an independent and the dependent variable in the proposed model (i.e., knowledge sourcing initiative to learning effectiveness and shared understanding to learning effectiveness). They therefore did not signify problems of multicollinearity, which exists between independent variables [76].

TABLE II
PSYCHOMETRIC PROPERTIES OF REFLECTIVE CONSTRUCTS

Constructs	Item	Item Loading*	T-Value
Absorptive Capacity (AC)	AC1	0.77	5.87
$\alpha = 0.76$; CR = 0.86; AVE = 0.66	AC2	0.84	16.07
	AC3	0.83	8.69
Learning Orientation (LO)	LO1	0.91	34.19
$\alpha = 0.91$; CR = 0.94; AVE = 0.79	LO2	0.88	25.39
	LO3	0.91	43.32
	LO4	0.87	24.78
Shared Understanding (SU) with Professors[+]	SU1	0.91	54.03
$\alpha = 0.70$; CR = 0.83; AVE = 0.73	SU2	0.81	38.20
Shared Understanding (SU) with Peers[+]	SU3	0.84	33.81
$\alpha = 0.86$; CR = 0.91; AVE = 0.87	SU4	0.84	32.82
Pro-sharing Norms (PSN)	PSN1	0.82	13.36
$\alpha = 0.87$; CR = 0.91; AVE = 0.73	PSN2	0.85	23.11
	PSN3	0.91	40.70
	PSN4	0.81	19.34
Learning Effectiveness (LE)	LE1	0.88	35.66
$\alpha = 0.87$; CR = 0.91; AVE = 0.73	LE2	0.87	33.30
	LE3	0.87	29.59
	LE4	0.79	17.38

*All item loadings are significant at p<0.001; [+] First order reflective constructs that compose Shared Understanding; α = Cronbach's Alpha; CR = Composite Reliability; AVE = Average Variance Extracted

TABLE III
FACTOR ANALYSIS

Construct and Items	AC	LO	PSN	LE
Absorptive Capacity (AC)				
AC1	**0.77**	0.09	0.07	0.07
AC2	**0.83**	0.16	0.06	0.16
AC3	**0.83**	0.35	0.08	0.10
Learning Orientation (LO)				
LO1	0.06	**0.91**	0.02	0.22
LO2	0.15	**0.88**	0.03	0.32
LO3	0.13	**0.90**	0.06	0.10
LO4	0.21	**0.86**	0.18	0.18
Pro-sharing Norm (PSN)				
PSN1	0.06	0.16	**0.82**	0.09
PSN2	0.02	0.01	**0.85**	0.15
PSN3	0.05	0.04	**0.91**	0.14
PSN4	0.11	0.08	**0.81**	0.22
Learning Effectiveness (LE)				
LE1	0.11	0.29	0.23	**0.89**
LE2	0.11	0.27	0.26	**0.86**
LE3	0.11	0.21	0.17	**0.88**
LE4	0.09	0.43	0.11	**0.79**
Variance % (Without Rotation)	**8.09**	**39.05**	**9.62**	**16.70**

TABLE IV
CONSTRUCT CORRELATION VS. SQUARE ROOT OF AVERAGE VARIANCE AND
DESCRIPTIVE STATISTICS

	AC	KSI	LO	NT	SU	PSN	LE	Mean	Standard Deviation
AC	**0.81**							4.88	0.99
KSI	0.13	N.A.						4.82	0.94
LO	0.43	0.24	**0.89**					5.35	0.83
NT	0.30	0.45	0.48	N.A.				4.89	1.25
SU	0.25	0.44	0.27	0.45	N.A.			4.57	1.18
PSN	0.24	0.44	0.27	0.37	0.23	**0.85**		4.76	0.99
LE	0.08	0.67	0.17	0.40	0.58	0.39	**0.85**	5.44	0.85

KSI: Knowledge Sourcing Initiative; NT: Network Ties; N.A.: AVE and square root of AVE were not calculated for formative constructs.

The degree of multicollinearity between all independent variables was further assessed by examining variable inflation factor (VIF). The resultant VIF values ranged from 1.27 for absorptive capacity to 1.85 for shared understanding, which were below the suggested threshold of 3.33 [77]. Therefore, bias due to multicollinearity was unlikely. Overall, the results indicate that the reliability and validity of all reflective constructs are adequate.

To further assess the measures of the dependent variable (i.e., learning effectiveness), we examined the correlation between the measures and the actual project grade received by the respondents. Results indicated that all items measuring learning effectiveness were strongly correlated with the actual grade, with all correlations significant at $p<0.001$ level (see Table V). This suggests that the perceptual measures of learning effectiveness are adequate.

TABLE V
CORRELATION OF LEARNING EFFECTIVENESS MEASURES AND ACTUAL
PROJECT GRADE

Learning Effectiveness Measures	Correlation with Actual Grade
LE1	0.74***
LE2	0.71***
LE3	0.60***
LE4	0.51***

***Correlation is significant at $p<0.001$

For the formative constructs of knowledge sourcing initiative and network ties, the absolute value of item weight (see Table VI) was examined to determine the relative contribution of items constituting each construct. Results indicated that all items contributed significantly to their respective constructs.

TABLE VI
ITEM WEIGHTS OF FORMATIVE CONSTRUCTS

Construct	Item	Item Weight	T-Value
Knowledge Sourcing Initiative (KSI)	KSI1	0.65***	10.02
	KSI2	0.41***	4.79
	KSI3	0.21**	2.62
Network Ties (NT) - Access	NT1	0.61***	7.39
	NT2	0.62***	5.89
Network Ties (NT) - Timeliness	NT3	0.59***	6.68
	NT4	0.62***	5.66

** Item significant at $p<0.01$ level (one-tailed T-value: 2.35);
*** Item significant at $p<0.001$ level (one-tailed T-value: 3.14)

We also assessed the extent of common method bias with Harman's one-factor test by entering all constructs into an unrotated principal components factor analysis [78]. The threat of common method bias is high if a single factor accounts for more than 50% of the variance [79]. Our results indicated that none of the factors significantly dominated the variance (see the last row of Table III) and common method bias was therefore unlikely.

B. Tests of Structural Model

To assess the interaction effects, a hierarchical moderated multiple regression using PLS was conducted. Specifically, the predictors were entered into the model in two steps. The first step included all independent variables. The interaction terms were entered into the model in the second step. The interaction terms were created based on the procedure suggested by Chin et al. [73]. To test the model, statistical significance of the path coefficients and variance explained (R^2) were assessed (see Table VII).

TABLE VII
RESULTS OF STRUCTURAL MODEL WITH PERCEIVED LE SCALE

	Path Coefficient	T Value	Result
Without Interaction Effects (R^2 =0.58)			
Absorptive Capacity (AC)	0.04	0.59	Not significant
Knowledge Sourcing Initiative (KSI)	0.11***	3.30	Significant
Learning Orientation (LO)	0.30***	3.32	Significant
Network Ties (NT)	0.02	0.27	Not significant
Shared Understanding (SU)	0.40***	5.09	Significant
Pro-sharing Norms (PSN)	0.20**	2.59	Significant
With Interaction Effects (R^2 =0.60)			
AC	0.04	0.53	H1 not supported
KSI	0.13*	2.16	H2 supported
LO	0.29**	2.51	H3 supported
NT	0.17	1.36	H4 not supported
SU	0.37**	2.85	H5 supported
PSN	0.12*	1.85	H6 supported
LO X NT	0.10*	2.18	H4a supported
AC X SU	0.08	0.37	H5a not supported
KSI X SU	0.04	0.73	H5b not supported
KSI X PSN	0.14*	1.90	H6a supported

*Path significant at $p<0.05$ (one-tailed T-value: 1.66); ** $p<0.01$ (one-tailed T-value: 2.35); *** $p<0.001$ (one-tailed T-value: 3.14)

The results show that the main effects of knowledge sourcing initiative (H2), learning orientation (H3), shared understanding (H5), and pro-sharing norms (H6) are significant. The interaction effect of H4a is significant, suggesting that the effect of individuals' learning orientation on learning effectiveness is contingent upon network ties as hypothesized. Hypothesis H6a is also supported, indicating that the effect of knowledge sourcing initiative on individuals' learning effectiveness is stronger when pro-sharing norms are higher. The main effects of absorptive capacity (H1) and network ties (H4), as well as the interaction effects involving shared understanding (H5a and H5b) are found to be not significant. None of the control variables are significant.

We also tested the model with learning effectiveness represented by actual project grade to examine if the results differed from that when the perceived learning effectiveness scale was used. The findings remained similar in terms of supported and unsupported hypotheses (see Table VIII)

indicating that the perceived LE scale is a reliable surrogate measure of the actual grade.

TABLE VIII
RESULTS OF STRUCTURAL MODEL WITH LE REPRESENTED BY ACTUAL GRADE

	Path Coefficient	T Value	Result
Without Interaction Effects (R²=0.59)			
Absorptive Capacity (AC)	0.06	0.75	Not significant
Knowledge Sourcing Initiative (KSI)	0.16***	4.24	Significant
Learning Orientation (LO)	0.22**	3.09	Significant
Network Ties (NT)	0.03	0.76	Not significant
Shared Understanding (SU)	0.40***	5.47	Significant
Pro-sharing Norms (PSN)	0.23**	3.10	Significant
With Interaction Effects (R²=0.62)			
AC	0.09	0.34	H1 not supported
KSI	0.14*	2.19	H2 supported
LO	0.21**	2.35	H3 supported
NT	0.21	1.18	H4 not supported
SU	0.39***	3.71	H5 supported
PSN	0.25*	1.69	H6 supported
LO X NT	0.28*	1.66	H4a supported
AC X SU	0.06	0.14	H5a not supported
KSI X SU	0.08	0.91	H5b not supported
KSI X PSN	0.35**	2.39	H6a supported
*p<0.05 (one-tailed T-value: 1.66); ** p<0.01 (one-tailed T-value: 2.35); *** p<0.001 (one-tailed T-value: 3.14)			

The model with both main and interaction effects explained significant variance (62%) in individuals' learning effectiveness. Learning orientation has the strongest direct and interaction effects among the individual factors while pro-sharing norms have the strongest direct and interaction effects among the social factors. The results are depicted in Fig. 2 and the implications of these findings are discussed next.
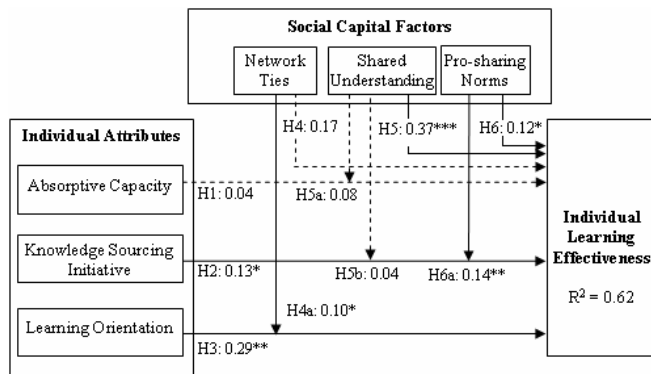

Fig. 2. Results of Structural Model

VI. DISCUSSION AND IMPLICATIONS

In essence, our findings suggest that individual and social factors interact to influence individuals' learning effectiveness. Specifically, we find that the symbolic cognition factors of knowledge sourcing initiative and learning orientation are significantly related to individuals' learning effectiveness. These individual factors also interact with the social factors of pro-sharing norms and network ties respectively. The social factors of shared understanding and pro-sharing norms also have significant direct influences on learning effectiveness.

Contrary to hypotheses, we find that absorptive capacity does not significantly influence individuals' learning effectiveness. This result deviates from previous findings on the role of prior knowledge in learning (e.g., [23]). Also, the interaction between absorptive capacity and shared understanding is not significant, although shared understanding has a significant direct effect on learning effectiveness. A possible reason for these results may be that the prior knowledge component of absorptive capacity of respondents in our study tended to be low as most of them had little prior experience in their research domain. Hence, these findings do not necessarily refute existing research. More studies on the effect of absorptive capacity in other contexts are needed to further explicate the relationships.

Also, the main effect of network ties is not significant, in contrast to past findings (e.g., [54]). However, we find that the interaction between network ties and learning orientation does influence learning effectiveness. These findings suggest that individuals' network ties play a supportive role in individual learning and need to be combined with high learning orientation to enhance learning effectiveness. In other words, timely and easy access to appropriate knowledge resources is not sufficient to promote learning unless the learner has a strong tendency to take on learning challenges. Nevertheless, it is still useful to improve the quality of network ties in a social system to facilitate learning for individuals with strong learning orientation.

Further, the relationship between knowledge sourcing initiative and individuals' learning effectiveness is found to be not contingent upon shared understanding as hypothesized. This finding suggests that the relational aspect of social capital (manifested as pro-sharing norms) is more important than the cognitive aspect (manifested as shared understanding) during knowledge sourcing. When gathering knowledge, the learner's main objective may be to obtain relevant knowledge from various sources (which is facilitated by pro-sharing norms) while shared understanding has a direct effect on learning effectiveness.

A. Theoretical Implications

This study contributes to research on individual learning in social contexts in several ways. First, the interaction effects of individual and social factors on individuals' learning effectiveness are empirically examined to better understand their joint effects. Although researchers have emphasized the importance of considering the effects of social factors in learning contexts such as the workplace (e.g., [35], [36]), prior studies have typically examined their effects separately from individual factors [13]. This study attempts to address the gap by showing that several interactions between them have significant influence on individuals' learning effectiveness. Although the findings are based on the study of undergraduate researchers in IT-related research projects in a university and need to be validated for other settings, they indicate the factors that may be salient and provide initial evidence for the interactions between individual and social factors in learning.

Second, drawing on the theoretical perspectives of symbolic

cognition, situated cognition, and social capital, the salient individual and social factors influencing individual learning are identified and their relative importance is assessed. Specifically, we find that learning orientation has the strongest direct and interaction effects among the individual factors while pro-sharing norms have the strongest direct and interaction effects among the social factors. This suggests that these factors should be accounted for in future studies on individual learning.

Third, as part of the empirical study, we have developed scales measuring individual absorptive capacity, knowledge sourcing initiative, network ties, and shared understanding in the context of individual learning. They demonstrate adequate reliability and validity as per the results of the pilot and full-scale studies. These and other scales adapted from prior studies (e.g., learning effectiveness) may be useful for future research on individual learning.

B. Practical Implications

Our findings indicate that both individual and social factors and their interactions have significant effects on individuals' learning effectiveness. It is important to note that our findings are based on a study of undergraduate researchers learning in IT-related projects in a university. While they may apply to new research hires into organizations, especially those with limited experience, they may not generalize to other employees. Nevertheless, the findings provide initial directions for promoting individual learning taking place in social contexts.

While both individual and social factors are found to be important to learning, the extent to which individual dispositions may be altered for the purpose of enhancing learning outcomes may be limited. This is highlighted in prior literature which suggests that although individual dispositions may have statistically significant effects on individual behavior in organizations, their effects may not be practically important or controllable as compared to organizational factors [80]. Our findings show that pro-sharing norms have the most significant influence on individuals' learning effectiveness among the antecedents considered. Further, the effects of learning orientation on learning effectiveness is enhanced by the social factor of network ties while shared understanding has a significant direct effect on learning effectiveness. Thus these social factors may be nurtured to facilitate learning in practice, as discussed next.

Prior studies have identified approaches for improving network ties, shared understanding, and pro-sharing norms. For example, in a case study of a multinational IT research and consulting firm's accrual of social capital [81], it was observed that *network ties* were improved by building electronic networks with communication tools such as discussion forums that allow users to seek knowledge from other employees, including those whom they had never previously communicated with. Such tools also have the capability of connecting individuals with external sources of knowledge such as industry experts and customers. Thus, these communication channels can help employees create strong ties

with relevant knowledge sources and enhance their learning effectiveness.

To promote *shared understanding*, taxonomies created along with discussion forums and electronic repositories had been found to be helpful in the case study [81]. It was observed that the taxonomies provided a common frame of reference for members of the organization that facilitated their communication. In addition, repositories of stories that documented experiences with important customers constitute shared narratives that helped new members better understand the organization's business and history.

To improve *pro-sharing norms*, the case study found that practices supporting the use of electronic knowledge repositories were effective [81]. In the firm studied, the importance of reusing knowledge and not reinventing the wheel had been ingrained in the employees by promoting the use of the knowledge repository. The value of sharing knowledge through the repository was clearly demonstrated in the form of better response and service to customers. As a result, employees became accustomed to share their knowledge in this manner. Other than facilitating learning through cultivating pro-sharing norms, knowledge repositories may also become a valuable source of knowledge.

VII. LIMITATIONS, FUTURE RESEARCH, AND CONCLUSION

Findings of this study should be interpreted in light of its limitations. First, data for this study were collected in a cross-sectional survey and we were therefore not able to conclusively determine causality for relationships found significant. However, with strong theoretical arguments, it is reasonable to believe that the relationships between cause and effect constructs operate as hypothesized. Nevertheless, it will be helpful to ascertain causality through a longitudinal study. One useful avenue for longitudinal research is to study how social capital develops as individuals progress through the learning journey and how these changes may impact future learning.

Second, as the data for this study were collected from a single kind of setting (i.e., learning in IT-related research projects in a university), caution must be exercised in generalizing the results to other samples, settings, and time periods. More studies in other knowledge-intensive organizations are needed to assess the external validity of the proposed model. The individual and social factors and interactions found significant in this study can be the focus of such studies. The survey instrument developed and validated in this study may also be useful.

Third, network ties were measured by respondents' perceived access to professors and other students and the timeliness of access rather than by mapping the network of relationships among them. Future research may collect more extensive network data to gain deeper insights into the role of network ties. For example, it may be useful to compare a learner's position in a network with other learners to examine whether it has an impact on learning outcomes.

In general, learning is viewed as a critical and effective mechanism that can facilitate continual development in individuals and organizations to respond to the rapidly changing environment. It is therefore imperative to investigate the means through which individuals gather and assimilate new knowledge. Results of this study indicate the need to integrate both symbolic and situated cognition perspectives in understanding individual learning and suggest social factors that may be nurtured to foster a conducive learning environment. As one of the first studies that unite previously disjoint views, we hope the proposed model can serve as a stepping stone for constructing a more comprehensive understanding of individual learning in organizations.

REFERENCES

[1] J. Ruiz-Mercader, A. L. Meroño-Cerdan, and R. Sabater-Sánchez, "Information technology and learning: Their relationship and impact on organisational performance in small businesses," *International Journal of Information Management*, vol. 26, no. 1, pp. 16-29, 2006.

[2] P. M. Senge, *The fifth discipline: The art and practice of the learning organization*, Random House, 2006.

[3] Y. Li, C. Zhang, Y. Liu, and M. Li, "Organizational learning, internal control mechanisms, and indigenous innovation: The evidence from China," *IEEE Transactions on Engineering Management*, vol. 57, no. 1, pp. 63-77, 2010.

[4] P. Soh, and A. M. Subramanian, "Is usage a missing link in explaining the perceived learning outcome of technology-mediated learning?," *IEEE Transactions on Engineering Management*, vol. 55, no. 1, pp. 50-66, 2008.

[5] D. A. Nembhard, and M. V. Uzumeri, "An individual-based description of learning within an organization," IEEE *Transactions on Engineering Management*, vol. 47, no. 3, pp. 370-378, 2000.

[6] G. Salomon, and D. N. Perkins, "Individual and social aspects of learning," *Review of Research in Education*, vol. 23, no. 1, pp. 1-24, 1998.

[7] J. Bruner, *Acts of meaning*, Harvard University Press, 1990.

[8] S. C. Kang, S. S. Morris, and S. A. Snell, "Relational archetypes: Organizational learning and value creation extending the human resource architecture," *Academy of Management Review*, vol. 32, no. 1, pp. 236-256, 2007.

[9] A. Fuller, H. Hodkinson, and P. Hodkinson, "Learning as peripheral participation in communities of practice: A reassessment of key concepts in workplace learning," *British Educational Research Journal*, vol. 31, no. 1, pp. 49-68, 2005.

[10] L. K. Gundry, "Fitting into technical organizations: The socialization of newcomer engineers," *IEEE Transactions on Engineering Management*, vol. 40, no. 4, pp. 335-345, 1993.

[11] J. Lave, and E. Wenger, *Situated learning: Legitimate peripheral participation*, Cambridge University Press, 1991.

[12] J. Wertsch, *Sociocultural studies of mind (learning in doing: Social, cognitive & computational perspectives)*, Cambridge University Press, 1995.

[13] S. Lähteenmäki, J. Toivonen, and M. Mattila, "Critical aspects of organizational learning research and proposals for its measurement," *British Academy of Management*, vol. 12, no. 2, pp. 113-129, 2001.

[14] M. Alavi, "Computer-mediated collaborative learning: An empirical evaluation," *MIS Quarterly*, vol. 18, no. 2, pp. 159-174, 1994.

[15] K. Lonka, E. Joram, and M. Bryson, "Conceptions of learning and knowledge: Does training make a difference?" *Contemporary Educational Psychology*, vol. 21, no. 3, pp. 240-260, 1996.

[16] L. A. A. Doumas, and J. E. Hummel, "Modeling human mental representations: What works, what doesn't, and why," in *The Cambridge Handbook of Thinking and Reasoning*, K. J. Holyoak, and R. G. Morrison (eds.) , Cambridge University Press, pp. 73-91, 2005.

[17] R. Glaser, M. T. H. Chi, and M. J. Farr, *The nature of expertise*, Lawrence Erlbaum Associates, 1988.

[18] R. N. Giere, *Explaining science: A cognitive approach*, University of Chicago Press, 1988.

[19] A. C. R. van Riel, and A. Lievens, "New service development in high tech sectors: A decision making perspective," *International Journal of Service Industry Management*, vol. 15, no. 1, pp. 72-101, 2004.

[20] W. M. Cohen, and D. A. Levinthal, "Absorptive capacity: A new perspective on learning and innovation," *Administrative Science Quarterly*, vol. 35, no. 1, pp. 128-152, 1990.

[21] G. Szulanski, "Exploring internal stickiness: Impediments to the transfer of best practice within the firm," *Strategic Management Journal*, vol. 17, no. 10, pp. 27-43, 1996.

[22] A.N.K. Chen, and T.M. Edgington, "Assessing value in organizational knowledge creation: Considerations for knowledge workers," *MIS Quarterly*, vol. 29, no. 2, pp. 279-309, 2005.

[23] A. M. Shapiro, "How including prior knowledge as a subject variable may change outcomes of learning research," *American Educational Research Journal*, vol. 41, no. 1, pp. 159-189, 2004.

[24] T. L. Griffith, J. E. Sawyer, and M. A. Neale, "Virtualness and knowledge in teams: Managing the love triangle of organizations, individuals, and information technology," *MIS Quarterly*, vol. 27, no. 2, pp. 265-287, 2003.

[25] X. Deng, W. J. Doll, and M. Cao, "Exploring the absorptive capacity to innovation/productivity link for individual engineers engaged in IT-enabled work," *Information & Management*, vol. 45, no. 2, pp. 75-87, 2008.

[26] J. -H. Park, H. -J. Suh, and H. -D. Yang, "Perceived absorptive capacity of individual users in performance of enterprise resource planning (ERP) usage: The case for Korean firms," *Information & Management*, vol. 44, no. 3, pp. 300-312, 2007.

[27] T. J. Shuell, "Learning theory and instructional design: Engaging the learner in meaningful ways," *Asia Pacific Journal of Education*, vol. 12, no. 2, pp. 1-10, 1992.

[28] P. H. Gray, and D. B. Meister, "Knowledge sourcing effectiveness," *Management Science*, vol. 50, no. 6, pp. 821-834, 2004.

[29] T. S. Bateman, and J. M. Crant, "The proactive component of organizational behavior: A measure and correlates," *Journal of Organizational Behavior*, vol. 14, no. 2, pp. 103-118, 1993.

[30] Q. -J. Yeh, "Exploring career stages of midcareer and older engineers---when managerial transition matters," *IEEE Transactions on Engineering Management*, vol. 55, no. 1, pp. 82-93, 2008.

[31] B. S. Bell, and S. W. J. Kozlowski, "Goal orientation and ability: Interactive effects on self efficacy, performance, and knowledge," *Journal of Applied Psychology*, vol. 87, no. 3, pp. 497-505, 2002.

[32] C. S. Dweck, and E. L. Leggett, "A social-cognitive approach to motivation and personality," *Psychological Review*, vol. 95, no. 2, pp. 256-273, 1988.

[33] D. V. D. Walle, S. Ganesan, and G. N. Challagalla, "An integrated model of feedback: Seeking behavior disposition, context, and cognition," *Journal of Applied Psychology*, vol. 85, no. 6, pp. 996-1003, 2000.

[34] E. R. Smith, and G. R. Semin, "Situated social cognition," *Current Directions In Psychological Science*, vol. 16, no. 3, pp. 132-135, 2007.

[35] P. Bryans, and R. Smith, "Beyond training: Reconceptualising learning at work," *Journal of Workplace Learning*, vol. 12, no. 6, pp. 228-235, 2000.

[36] R. F. Korte, "A review of social identity theory with implications for training and development," *Journal of European Industrial Training*, vol. 31, no. 3, pp. 166-180, 2007.

[37] N. Lin, *Social capital: A theory of social structure and action*, Cambridge University Press, 2001.

[38] J. Nahapiet, and S. Ghoshal, "Social capital: Intellectual capital and organizational advantage," *Academy of Management Review*, vol. 23, no. 2, pp. 242-266, 1998.

[39] K. Ecclestone, and J. Field, "Promoting social capital in a "risk society": A new approach to emancipatory learning or a new moral authoritarianism?," *British Journal of Sociology of Education*, vol. 24, no. 3, pp. 267-282, 2003.

[40] D. Cohen, and L. Prusak, *In good company: How social capital makes organizations work*, McGraw-Hill, 2001.

[41] K. C. Lee, S. Lee, and I. W. Kang, "KMPI: Measuring knowledge management performance," *Information & Management*, vol. 42, no. 3, pp. 469-482, 2005.

[42] P. S. Adler, and S. Kwon, "Social capital: Prospects for a new concept," *Academy of Management Review*, vol. 27, no. 1, pp. 17-40, 2002.

[43] R. S. Burt, *Structural holes: The social structure of competition*, Harvard University Press, 1992.

[44] W. Swap, D. Leonard, and M. Shields, "Using mentoring and storytelling to transfer knowledge in the workplace," *Journal of Management Information Systems*, vol. 18, no. 1, pp. 95-114, 2001.

[45] K. Nelson, and J. Cooprider, "The contribution of shared knowledge to is group performance," *MIS Quarterly*, vol. 20, no. 4, pp. 409-429, 1996.

[46] R. Boland, and R. Tenkasi, "Perspective making and perspective taking in communities of knowing," *Organization Science*, vol. 6, no. 4, pp. 350-372, 1995.

[47] M. Alavi, and A. Tiwana, "Knowledge integration in virtual teams: The potential role of knowledge management systems," *Journal of the American Society for Information Science and Technology*, vol. 53, no. 12, pp. 1029-1037, 2002.

[48] J. S. Coleman, *Foundations of social theory*, Belknap Press of Harvard University Press, 1990.

[49] A. Kankanhalli, B. C. Y. Tan, and K. K. Wei, "Contributing knowledge to electronic knowledge repositories: An empirical investigation," *MIS Quarterly*, vol. 29, no. 1, pp. 113-143, 2005.

[50] J. Barney, "Firm resources and sustained competitive advantage," *Journal of Management*, vol. 17, no. 1, pp. 99-120, 1991.

[51] G. H. Bower, and E. R. Hilgard, *Theories of learning*, Prentice Hall, 1981.

[52] B. Levitt, and J. G. March, "Organizational learning," *Annual Review of Sociology*, vol. 14, no. 1, pp. 319-338, 1988.

[53] M. Hansen, "The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits," *Administrative Science Quarterly*, vol. 44, no. 1, pp. 82-111, 1999.

[54] R. T. Sparrow, R. C. Liden, and S. J. Wayne, "Social networks and the performance of individuals and groups," *Academic Management Journal*, vol. 44, no. 2, pp. 316-325, 2001.

[55] I. Nonaka, "A dynamic theory of organizational knowledge creation," *Organization Science*, vol. 5, no. 1, pp. 14-37, 1994.

[56] S. L. Jarvenpaa, and D. S. Staples, "The use of collaborative electronic media for information sharing: An exploratory study of determinants," *Journal of Strategic Information Systems*, vol. 9, no. 2-3, pp. 129-154, 2000.

[57] P. S. Goodman, and E. Darr, "Computer-aided systems and communities: Mechanisms for organizational learning in distributed environments," *MIS Quarterly*, vol. 22, no. 4, pp. 417-440, 1998.

[58] D. Z. Levin, E. M. Whitener, and R. Cross, "Perceived trustworthiness of knowledge sources: The moderating impact of relationship length," *Journal of Applied Psychology*, vol. 91, no. 5, pp. 1163-1171, 2006.

[59] C. Kao, and H. -T. Hung, "Efficiency analysis of university departments: An empirical study," *Omega: The International Journal of Management Science*, vol. 36, no. 4, pp. 653-664, 2008.

[60] G. A. Churchill, "A paradigm for developing better measures of marketing construct," *Journal of Marketing Research*, vol. 16, no. 1, pp. 64-73, 1979.

[61] G. C. Moore, and I. Benbasat, "Development of an instrument to measure the perceptions of adopting an information technology innovation," *Information Systems Research*, vol. 2, no. 3, pp. 192-222, 1991.

[62] C. B. Jarvis, S. B. MacKenzie, and P. M. Podsakoff, "A critical review of construct indicators and measurement model misspecification in marketing and consumer research," *Journal of Consumer Research*, vol. 30, no. 3, pp. 199-218, 2003.

[63] R. C. MacCallum, M. W. Browne, and H. M. Sugawara, "Power analysis and determination of sample size for covariance structure modeling," *Psychological Methods*, vol. 1, no. 2, pp. 130-149, 1996.

[64] R. T. Cenfetelli, and G. Bassellier, "Interpretation of formative measurement in information systems research," *MIS Quarterly*, vol. 33, no. 4, pp. 689-708, 2009.

[65] S. Petter, D. Straub, and A. Rai, "Specifying formative constructs in information systems research," *MIS Quarterly*, vol. 31, no. 4, pp. 623-656, 2007.

[66] J. F. Brett, and D. VandeWalle, "Goal orientation and specific goal content as predictors of performance in a training program," *Journal of Applied Psychology*, vol. 84, no. 6, pp. 863-873, 1999.

[67] M. M. Wasko, and S. Faraj, "Why should I share? Examining social capital and knowledge contribution in electronic networks of practice," *MIS Quarterly*, vol. 29, no. 1, pp. 35-57, 2005.

[68] R. Cross, and J. Cummings, N., "Tie and network correlates of individual performance in knowledge-intensive work," *The Academy of Management Journal*, vol. 47, no. 6, pp. 928-937, 2004.

[69] K. G. Pillai, "Networks and competitive advantage: A synthesis and extension," *Journal of Strategic Marketing*, vol. 14, no. 2, pp. 129-145, 2006.

[70] M. Rhee, "Network updating and exploratory learning environment," *Journal of Management Studies*, vol. 41, no. 6, pp. 933-949, 2004.

[71] C. M. Ringle, S. Wende, and A. Will, *SmartPLS 2.0 (beta)*, University of Hamburg, 2005.

[72] J. C. Nunnally, and I. Bernstein, *Psychometric theory*, McGraw-Hill, 1993.

[73] W. W. Chin, B. L. Marcolin, and P. R. Newsted, "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*, vol. 14, no. 2, pp. 189-217, 2003.

[74] D. Gefen, and D. W. Straub, "A practical guide to factorial validity using PLS-graph: Tutorial and annotated example," *Communications of the Association for Information Systems*, vol. 16, no. 5, pp. 91-109, 2005.

[75] C. Fornell, and D. Larcker, "Evaluating structural equation models with unobservable variables and measurement error," *Journal of Marketing Research*, vol. 18, no. 1, pp. 39-50, 1981.

[76] H. M. J. Blalock, "Correlated independent variables: The problem of multicollinearity," *Social Forces*, vol. 42, no. 2, pp. 233-237, 1963.

[77] A. Diamantopoulos, and H. M. Winklhofer, "Index construction with formative indicators: An alternative to scale development," *Journal of Marketing Research*, vol. 38, no. 2, pp. 269-277, 2001.

[78] P. Podsakoff, and M. Organ, "Self-reports in organizational research: Problems and prospects," *Journal of Management*, vol. 12, no. 4, pp. 531-544, 1986.

[79] H. H. Harman, *Modern factor analysis*, University of Chicago Press, 1960.

[80] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly*, vol. 13, no. 3, pp. 319-339, 1989.

[81] K. Sherif, J. Hoffman, and B. Thomas, "Can technology build organizational social capital? The case of a global IT consulting firm," *Information & Management*, vol. 43, no. 7, pp. 795-804, 2006.
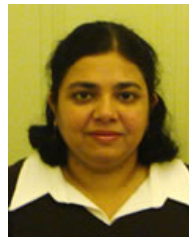
A. Kankanhalli is Associate Professor in the Department of Information Systems at the National University of Singapore (NUS). She obtained her B. Tech. from the Indian Institute of Technology Delhi, M.S. from the Rensselaer Polytechnic Institute, New York, and Ph.D. from NUS. She had visiting stints at the University of California Berkeley and Indian Institute of Science Bangalore. Dr. Kankanhalli has considerable work experience in industrial R&D and has consulted for several organizations including World Bank and Bosch SEA. She conducts research in the areas of knowledge management, IT enabled organizational forms, and IT in service sectors, supported by government and industry grants. Her work has appeared in *MIS Quarterly*, *Journal of Management Information Systems*, *IEEE Transactions on Engineering Management*, *Journal of AIS, Journal of the American Society for Information Science and Technology*, *International Journal of Human Computer Studies*, *Journal of Strategic Information Systems*, *European Journal of Information Systems*, *Communications of the ACM*, *Decision Support Systems*, and the International Conference on Information Systems and HICSS among others. She serves on several IS conference committees and on the editorial boards of the *MIS Quarterly*, *IEEE Transactions on Engineering Management*, and *Information and Management*, among others. Dr. Kankanhalli has been awarded the Infocomm Development Authority Gold Medal and the ACM SIGMIS 2003 Best Doctoral Dissertation award. She has been listed among the leading IS researchers globally and in the Asia Pacific region.

L. G. Pee is an Assistant Professor in the Graduate School of Decision Science and Technology at the Tokyo Institute of Technology. She received her Bachelor in Computing and Ph.D. in Information Systems (IS) from the National University of Singapore. Her research interests are in knowledge management, adoption of emerging technology, and perceived security and risks. Her work has been published in journals such as *Information & Management* and *Journal of the Association for Information Systems* and in proceedings of conferences such as the International Conference on Information Systems (ICIS) and Pacific Asia Conference on Information Systems (PACIS). She has served as an associate editor for ICIS. She is also a reviewer for journals and conferences such as *MIS Quarterly*, *Journal of the Association for Information Systems*, ICIS, PACIS, and Annual Meeting of the Academy of Management. Dr. Pee received the Best Paper Award of PACIS 2010.

G. W. Tan is an Assistant Professor in the School of Computing at the National University of Singapore (NUS). She received her M.Sc. degree in Computer Science from Indiana University (IU) and Ph.D. degree in Business Administration from University of Illinois at Urbana-Champaign (UIUC). Dr. Tan's primary research focuses on information sharing in supply chain network. In recent years, she has moved into website design and knowledge management. Her research work has been published in *IEEE Transactions on Engineering Management*, *Journal of Organizational Computing and Electronic Commerce*, and International Conference on Information Systems (ICIS).

S. Chhatwal received his Bachelor in Computing in Information Systems from the National University of Singapore (NUS). He currently runs and manages his own e-commerce company in Singapore providing educational and academic products globally to over ten countries.

APPENDIX: LIST OF CONSTRUCTS AND ITEMS

Construct	Item	Source
Absorptive Capacity (AC)	AC1: I often use prior knowledge to facilitate the progress of my research AC2: I often try to interrelate new learning with prior and related knowledge AC3: I find it easy to create associations and linkages between the research materials that I have previously studied	All items developed based on Cohen and Levinthal [20] and Szulanski [21]
Knowledge Sourcing Initiative (KSI)	KSI1: I often make use of written materials such as journals, books, articles on the WWW etc. to source for knowledge related to my research KSI2: I often approach professors to source for knowledge related to my research KSI3: I often approach other students to source for knowledge related to my research	All items developed based on Gray and Meister [28]
Learning Orientation (LO)	LO1: I often take up challenging tasks that can enhance my skills and learning LO2: I often put in extra effort so that I can enhance my skills and learning LO3: I often take up challenging tasks where I can learn new skills LO4: I often look for opportunities to enhance my knowledge and learning	All items adapted from Brett and VandeWalle [66]
Network Ties (NT)	NT1: Professors to assist my research are often readily accessible NT2: Other students to assist my research are often readily accessible NT3: The knowledge I need from professors is often available on time NT4: The knowledge I need from other students is often available on time	All items developed based on Nahapiet and Ghoshal [38] and Burt [43]
Shared Understanding (SU)	SU1: I am able to effectively exchange ideas with professors who are conducting research in areas related to mine SU2: I am able to effectively exchange ideas with other students who are conducting research in areas related to mine SU3: I am able to think and talk about ideas in similar ways as professors who are conducting research in areas related to mine. SU4: I am able to think and talk about ideas in similar ways as other students who are conducting research in areas related to mine	All items developed based on Nahapiet and Ghoshal [38]
Pro-sharing Norms (PSN)	PSN1: There is a strong norm of sharing knowledge in my organization PSN2: There is a strong willingness to value and respond to diversity in my organization PSN3: There is a strong norm of openness to conflicting views in my organization PSN4: There is a strong norm of tolerance of mistakes in my organization	All items adopted from Kankanhalli, et al. [49]
Learning Effectiveness (LE)	LE1: As a result of doing research on my project, there is a substantial improvement in my critical-thinking skills LE2: As a result of doing research on my project, there is a substantial improvement in my ability to integrate facts LE3: As a result of doing research on my project, there is a substantial improvement in my ability to identify central issues in my field LE4: I am very satisfied with the learning process	All items adapted from Alavi [14]