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A MULTILEVEL PERSPECTIVE ON KNOWLEDGE TRANSFER: EVIDENCE FROM THE CHINESE AUTOMOTIVE INDUSTRY

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We adopt a multilevel perspective to study the transfer of collective and individual knowledge. By making a clear theoretical distinction between collective and individual attributes in concepts such as knowledge, teaching approach, and absorptive capacity, this study extends the knowledge transfer literature and provides fresh insights into the ways in which collective and individual knowledge are transferred. Based on a survey of the capability transfer activities of 161 engineering units of multinationals in the Chinese automotive industry, we empirically validate the distinction between individual and collective teaching activities and absorptive capacity. More importantly, we find that the largely underexplored collective-level mechanisms, such as collective teaching and collective absorptive capacity, are more effective in transferring both collective knowledge and individual knowledge in comparison to their individual-based counterparts. Our findings also have important implications for management of multinationals and international joint ventures, particularly in emerging economies.

INTRODUCTION

In line with the Aristotelian world view that the whole is more than the sum of its parts, organizational scholars have suggested that organizational phenomena emerge not only from the aggregation of the attributes of individual members, but also from the overall architectural and interrelational pattern of the organization as a *collective* (Barnard, 1971; Hedberg, 1981; Kogut and Zander, 1992). It has been established that economic organizations exist because they can achieve *collectively,* through specialization and collaboration, what an unorganized group of individuals cannot (Becker, 1964; Schumpeter, 1934; Smith, 1776/2004). Essentially, collective activities are the *raison d'etre* of organizations. Despite its importance, the collective aspect of organizational phenomena has rarely been studied in explicit parallel with its individual-level counterpart. Realizing this limitation, a growing number of organization scholars have advocated the use of multilevel research to gain a more holistic understanding of organizational phenomena (Gupta, Tesluk, and Taylor, 2007; Hitt *et al*., 2007). For example, organizational learning involves both individual and collective learning (Argote, 1999; Crossan, Lane, and White, 1999), and innovation occurs at both individual and collective levels (Gupta *et al*., 2007).

In this study, we expand the multilevel approach to a particular organizational phenomenon, knowledge transfer, which is prevalent and critical to a firm's survival and competitiveness (Szulanski,

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1996; Teece, 1986). The existing empirical studies of knowledge transfer generally adopt one of three approaches: archival research with patent data (e.g., Mowery, Oxley, and Silverman, 1996), survey research (e.g., Almeida and Grant, 1998; Gupta and Govindarajan, 2000; Kogut and Zander, 1995; Lyles and Salk, 1996), and case study (e.g., Ranft and Lord, 2002; Zhao, Anand, and Mitchell, 2005). Those that use patent data focus mostly on the transfer of explicit knowledge, whereas those studies that adopt survey and case methods have more flexibility to study the transfer of implicit knowledge and provide richer details in the process of knowledge transfer, albeit often with the restriction of limited samples.

Knowledge transfer has been well studied in an array of settings including intraorganizational, interorganizational, and cross-border exchanges. Research has established that a firm's capabilities involve both individual and collective knowledge (Argote, 1999; Crossan *et al*., 1999; Nonaka and Takeuchi, 1995; Spender, 1996). However, we find two gaps in the extent of knowledge transfer research. First is the lack of empirical studies on the transfer of individual and collective knowledge as two distinct, yet parallel, outcomes. Collective knowledge is more valuable because it recombines individual knowledge and is the key to the value creation process (Kogut and Zander, 1992). However, because collective knowledge is predominantly implicit and embedded among the norms and routines of multiple organizational members (Spender, 1996), its transfer is more challenging and prone to failure (Collis and Montgomery, 1995). Clearly, there is a difference in the nature, strategic importance, and level of transfer difficulty of collective versus individual knowledge. Therefore, we believe that to gain a fuller understanding of knowledge transfer, it is imperative to study the transfer of these two types of knowledge separately. The second gap in the research is the lack of multilevel studies pertaining to the key influencing factors of knowledge transfer such as teaching and absorptive capacity, which, in order to gain a holistic understanding, need to be studied at both the individual and collective levels.

To fill these two gaps, we use a multilevel perspective to study both the outcome of knowledge transfer and the factors, such as teaching and absorptive capacity, that affect it. Specifically, we address the following questions. First, does teaching activity, like its matching activity, learning, occur at both the individual and collective levels? Second, does the distinction between the individual and the collective also exist in another key knowledge transfer construct, absorptive capacity? Lastly, how do teaching activities and absorptive capacities at different levels (i.e., individual vs. collective) affect the transfer of these two distinct types of knowledge? Based on survey data from 161 engineering units within multinational automotive firms operating in China, we found that collective constructs, such as collective teaching activities and collective absorptive capacity, are more effective than their individual counterparts in ensuring the transfer of both collective and individual knowledge.

Our study contributes to the knowledge transfer research and the general knowledge-based literature by (1) establishing an individual vs. collective distinction in constructs such as teaching and absorptive capacity, and (2) developing a multilevel causal model of knowledge transfer. Our findings have particularly strong implications for knowledge transfer in multinationals and across joint venture partners, particularly in emerging economies where there can be a great deal of asymmetry in the knowledge stocks of multinational sources and local recipient organizations. We also reveal several blind spots of managers, who, in their attempts to acquire capabilities, typically put more emphasis on individual teaching activities and individual absorptive capacity than on collective teaching activities and collective absorptive capacity.

THEORY AND HYPOTHESES

A multilevel perspective on knowledge transfer

One of the persisting issues in management studies is that '[m]ost management problems involve multilevel phenomena, yet most management research uses a single level of analysis' (Hitt *et al*., 2007: 1385). Knowledge transfer is a multilevel process. When firms transfer organizational capabilities from one unit to another, they transfer not only individually held skills, but also organizationally embedded knowledge or collective knowledge, that is, the knowledge embedded among organizational members regarding how to coordinate, share, distribute, and recombine individual knowledge (Kogut 1988; Argote and Ingram, 2000; Grant,

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1996; Spender, 1996).[1] Prior studies have established that learning, the action taken by the receiving end of knowledge transfer, can also occur either individually or collectively. Collective-level learning is conceptualized as the organization-wide activities that engage multiple members of the organization in interactively sharing, creating, and integrating their individual knowledge (Argote, 1999; Crossan *et al*., 1999).[2] It is different from learning independently as individuals, that is, individual learning. Based on the conceptualization of individual vs. collective knowledge and learning, it may be clear that although collective-level constructs share the same concept domain with their individual counterpart,[3] collective-level constructs describe the *interrelatedness* among members or the *global* properties of the entire organization, and hence, are beyond the simple sum of individual constructs (Klein and Kozlowski, 2000).

Expanding this line of work, we conceptualize and examine the distinction between individual and collective in two additional key constructs in the area of knowledge transfer: the teaching activities of the source organization and the absorptive capacity of the receiving organization. Before we further discuss these concepts and develop our hypotheses in the next section, we need to make three important clarifications. First, all individual-based constructs in our study, such as individual knowledge, individual teaching, and individual absorptive capacity, originate at the individual level but are aggregated to the organizational level of analysis through the bottom-up *composition* process since they describe isomorphic phenomena[4] (Klein and Kozlowski, 2000). For instance, the construct of individual knowledge in our study refers to the overall stock of individual knowledge of the organization, the construct of individual teaching is the total amount of individual teaching provided to the receiving organization, and the construct of individual absorptive capacity is the aggregation of the prior knowledge of the individual members of the receiving organization. In contrast, the collective-based constructs in this study, such as collective knowledge, collective teaching, and collective absorptive capacity, are either global properties of the organization or have emerged from the individual level through a *compilation* process (Klein and Kozlowski, 2000). They describe the systemic, interrelational, and architectural aspects of the organization, and thus are not reducible to a simple aggregation of individual attributes or efforts. We will explain the contrast between the individual- and collective-based construct in greater detail in the following section and in Table 1. The key point we want to make here is that the individual-based construct is just a simple aggregation of individual attributes, whereas the true collective constructs describe the interrelationship and global aspect of the organization and thus cannot be reduced to the sum of individual attributes.

Second, we want to emphasize that an organizational phenomenon is an organic combination of both individual-based and collective-based aspects (Hackman, 2003). For instance, organizational knowledge consists of both the sum of individual members' knowledge and the collective knowledge held among all members. Similarly, organizational learning efforts involve both the aggregation of individual members' learning efforts and the collective learning efforts among all members (Crossan *et al*., 1999). The collective and the sum of individuals are not two extremes of one construct, but rather two distinct and coexisting constructs.

Finally, it is important to point out that following the examples of prior survey research on knowledge transfer studies (Kale, Singh, and Perlmutter, 2000; Lyles and Salk, 1996), we define the extent of knowledge transferred as the improvement of a receiving organization's knowledge stock (either in individual or collective form), or more specifically, the incremental productivity or efficiency gained through the teaching of the source organization and the learning of the recipient organization (Baum and Ingram, 1998). In reality, capability cannot be exactly replicated due to the contextual

[1] Examples of collective knowledge include inter-functional routines and procedures (Nelson and Winter, 1982; Kogut and Zander, 1992). Organizational routines such as Nelson and Winter's (1982) study involve both individual knowledge (i.e., individual ability to receive, process, and act upon information) and collective knowledge (i.e., the interaction patterns among individuals either within a functional area or across functional areas). Therefore, only the interpersonal or inter-functional routines should be considered as collective knowledge.

[2] These studies suggest that learning occurs at three levels: individual, group, and organization. To simplify our discussion, we focus on the distinction between individual and collective, which includes both the group and the organization.

[3] For example, both collective knowledge and individual knowledge are forms of knowledge. But collective knowledge is a different type of knowledge from individual knowledge.

[4] A simple illustration of isomorphic phenomena is that a basket of apples is still considered apples.

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Table 1. Comparison between individual and collective constructs

Concepts		Individual	Collective
Knowledge	Definition	The total stock of individually held task-specific knowledge with a unit.	The knowledge embedded among organizational members regarding how to coordinate, share, distribute, and recombine individual knowledge (Brown and Duguid, 2001; Kogut and Zander, 1992; Grant, 1996; Spender, 1996)
	Examples and measurements	Job-specific skills	Interpersonal routines
		Individual routines	Interfunctional routines and procedures,
Teaching	Definition	Knowledge imparting activity carried out by individuals of a source entity in an independent manner.	A process in which members of the source organization collectively impart the knowledge and mindset to the individuals of the receiving organization (Zhao *et al*., 2004)
	Examples and measurements	1. Classroom lecturing	1. Team teaching, that is, sending a large team of expatriates from the source organization to work at the site of the recipient organization (Galbraith, 1990).
		2. One-on-one apprenticeship	2. Overseas on-the-job training, that is, sending individual members of the recipient organization to work at the site of the source organization (Florida and Kenney, 2000; Inkpen and Dinur, 1998; Prochno, 2003)
		3. Sending individual expatriates from the source organization to the recipient organization to train its employees	
Absorptive capacity	Definition	The aggregation of the prior relevant knowledge or experiences of the individual members of a recipient community (Cohen and Levinthal, 1990; Matusik and Heeley, 2005)	The structural and cultural attributes of the receiving organization as a whole that are conducive to acquiring and assimilating new knowledge
	Examples and measurements	1. Number of patents	1. Communication, information, and knowledge management systems (Cohen and Levinthal, 1990; Henderson and Clark, 1990; Youndt, Subramaniam, and Snell, 2004)
		2. Number of engineering personnel	2. Corporate culture characterized by collaboration and learning orientation. (Collins and Smith, 2006; Nahapiet and Ghoshal, 1998; Bunderson and Sutcliffe, 2003
		3. Percentage of employees that have certain skills or experiences, are individual-based and should be categorized as individual absorptive capacity (Luo, 1997; Matusik and Heeley, 2001)	

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difference between the source and the receiving organizations. However, the stock of the recipient organization's knowledge of how to operate efficiently and effectively will improve as the knowledge of the source organization is transferred.

Collective teaching and individual teaching

Although knowledge transfer involves both teaching activities by the source organization and learning efforts by the receiving organization, the literature on teaching is nearly absent in the management field, particularly when compared to the large body of literature on learning. Teaching is the action carried out by a source entity that imparts knowledge, skill, and a mindset to a receiving entity.[5] It does not necessarily restrict itself to the narrow conceptual scope of formal instructions. The most common perception of teaching is that of *individual teaching,* in which the knowledge imparting activity is carried out by an individual source entity. Classroom lecturing and apprenticeship are examples of individual teaching. For example, in joint ventures, individual teaching may take place if the source partner sends expatriates to train joint venture employees. In fact, the contract clauses that specify the required quantity of individual teaching, in person-hours, by the source partner are often an important part of joint venture technology transfer agreements.

Contrary to the common perception that the individual is the primary undertaker of teaching activities, teaching activities of the source organization can also be carried out collectively, just as learning may take place collectively (Zhao, Anand, and Mitchell, 2004). *Collective teaching* is a process in which members of the source organization collectively impart the knowledge, routines, and mindset of their organization to the individuals of the receiving organization. The entity that carries out collective teaching is a tightly interrelated collective, which we call the *source community*. In essence, when teaching collectively, the source community presents to the individuals of the receiving organization a holistic and intricate picture of the pattern of interactions among its members as they coordinate to recombine their knowledge and create new knowledge (Nonaka and Takeuchi, 1995). In the field of education, a similar approach to collective teaching is team teaching, which ranges from the simple format of multiple teachers in a single course, to more complex learning communities and linked courses (Shaplin and Olds, 1964). Team teaching pedagogy has been attempted in many institutions (Wenger and Hornyak, 1999).

In the context of knowledge transfer, we identify two practical forms of collective teaching from the literature and from our field observations. The first type of collective teaching is similar to the study abroad approach, for which the source organization, usually the foreign partner of the joint venture or the foreign parent of a wholly owned subsidiary, hosts individual(s) of the receiving organization (i.e., the joint venture or the wholly owned subsidiary) for overseas on-the-job training associated with joint engineering projects (Florida and Kenney, 2000; Inkpen and Dinur, 1998; Prochno, 2003). The second type of collective teaching is carried out when the source organization sends a sizeable team of expatriates to work at the site of the receiving organization (Galbraith, 1990). For example, a foreign partner of a particular joint venture in our field study sent a team of more than 20 expatriates to occupy essentially all key positions in the joint venture. The manager believed that by doing so, the Chinese employees could get 'blanket exposure' to the managerial practices of the foreign partner firm and, as a result, might acquire these practices more quickly and effectively. Please see the Appendix for more practical examples of collective teaching.

Collective teaching is different from the sum of individual teaching for two reasons. First, the teaching entity of collective teaching is not a group of *independent* individuals, but rather an *interdependent* collective, which forms an integral source community. Second, the teaching style of collective teaching is not one-on-one or one-on-many, but rather a demonstration of interactive patterns among multiple individuals within the source community. Collective teaching allows an individual learner to observe how the source community as a whole interacts to solve complex problems. Collective teaching and individual teaching are mutually independent. In fact, firms use individual and collective teaching simultaneously in their knowledge transfer practices.

[5] It should be noted that in this article we refer to teaching as an action of knowledge impartation, which is different from the concept of teachability introduced by Kogut and Zander (1988), which is an attribute of knowledge tacitness.

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Collective teaching's effect on transferring collective knowledge

Collective knowledge is the knowledge embedded among organizational members regarding how to coordinate, share, distribute, and recombine individual knowledge (Berger and Luckmann, 1966; Brown and Duguid, 2001; Kogut and Zander, 1992; Spender, 1996; Spender and Grant, 1996; Weick and Roberts, 1993). Because the interrelations and coordination among individuals are too vast and situational to be fully codified, collective knowledge is much more difficult for the members of the receiving organization to observe and understand than is individual knowledge.

Collective teaching is well suited for imparting the collective knowledge of a source community to learning individuals for the following reasons. First, with collective teaching, the source community exposes the interactions among their members to the recipients, thus allowing them to observe firsthand and understand the coordination routines embedded among the members of the source organization that are hard to fully codify. According to the education literature, one of the main benefits of team teaching is that it assists students with learning how teachers interact with each other to solve problems (Wenger and Hornyak, 1999). In an empirical study of knowledge transfer, Prochno (2003) found that a form of collective teaching, namely overseas training, helps the members of the recipient organization to gain a solid understanding of the source organization's interpersonal and cross-functional coordination patterns and their meaning.

In addition, it has been argued that the values of an organization tend to structure both employees' ways of thinking and their behavior by forming the basis of expectations. Newcomers to an organization that carries certain values tend to adopt such values and comply with expectations due to social pressure (March, 1988, cited by Nonaka and Nishiguchi, 2001). Collective teaching, by situating individual learners in the large environment of the source community, also presents a social pressure to the learning individuals, motivating them to internalize the new values and mindsets needed for performing certain tasks (Weick and Roberts, 1993).

Finally, most knowledge is situated in specific contexts (Lave and Wenger, 1991). Collective teaching allows members of the recipient organization to participate in the daily interactions of the source community, which in turn may assist them in understanding the cultural and institutional context in which the collective knowledge (e.g., interfunctional routines) is situated. A prior case study of knowledge transfer found that 'most [members of the recipient organization] were sent abroad so that they could, through observation and practice, internalize values and norms attached to the roles they would perform in the new plant' (Prochno, 2003: 20).

Therefore, collective teaching, either in the form of overseas training or expatriate teams working at the recipient's site, helps individuals of the receiving organization to observe and understand the collective knowledge embedded in the interactions among the members of the source community.

> *Hypothesis 1a: The more extensive the source organization's use of collective teaching activities, the greater the improvement of the receiving organization's stock of collective knowledge.*

The differential effects of collective vs. individual teaching on transferring collective knowledge

Individual teaching, which is the teaching carried out by individual members of the source community in an independent manner, does not share the aforementioned three advantages of collective teaching. Although individual teaching is suitable for imparting decontextualized knowledge that is free from the engagement with the particularities of time, place, and ongoing activity (Lave and Wenger, 1991), it is significantly less capable than collective teaching of describing the pattern of interaction among members of the source community. Since the majority of the collective knowledge embedded in the source community is hard to codify as well as situational, it cannot be fully conveyed by individual teachers. In addition, individual teaching is incapable of providing both the social pressure and the institutional context to assist learning individuals in fully grasping the collective knowledge.

The contrast between collective teaching and individual teaching is clearly illustrated by comparing two approaches in the context of teaching a second language—the study abroad approach and the formal classroom approach. The study abroad

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approach can be categorized as collective teaching, because the teaching entity is a collective community of the native speakers of the target language. This type of teaching exposes students to the linguistic and cultural context of a foreign language (Collentine and Freed, 2004). In contrast, the formal classroom approach can be considered individual teaching because the teaching entity is simply an individual teacher of the target language.

In our field study, when asked to compare the effectiveness of collective- and individual-level teaching for transferring engineering capabilities, all respondents agreed on the superiority of collective teaching over individual teaching, particularly in regard to acquiring collective knowledge such as interpersonal and inter-functional coordination routines, which are a key part of engineering capabilities. Clearly, it 'takes a village' (i.e., a source community) to teach the learning individuals about collective knowledge.

Hypothesis 1b: The source organization's use of collective teaching activities has a greater positive impact than does its use of individual teaching activities on the improvement of the receiving organization's stock of collective knowledge.

Collective teaching's effect on transferring individual knowledge

The literature suggests that most job-related knowledge is context-constructed and can reveal itself only by being brought into play in specific circumstances (Kogut and Zander, 1992; Lave and Wenger, 1991). Thus, understanding knowledge context is an important condition for acquiring individual knowledge. Collective teaching provides the context needed for constructing individual knowledge. For instance, the best way for an individual to learn a foreign language skill is through 'immersion' in the community that uses this language. By being exposed to the way speakers of that language communicate with each other in different situations, the learner can pick up the linguistic and social context of this language effectively. In this regard, Hymes (1972) stated, 'the key to understanding language in context is to start not with language but with context ... [and then to] systematically relate the two' (1972, xix).

Similarly, our exploratory study also found that, by presenting the members of the receiving organization with a broad context of how their skills fit into the overall operation of the organization, collective teaching helps them to acquire individual skills better. For instance, a Chinese computer aided design (CAD) engineer from a joint venture in our exploratory study largely credited her improvement in CAD skills to a three-month overseas on-the-job training program, which provided her with a natural working environment to interact with foreign engineers. She said that this experience allowed her to understand how her job relates both functionally and temporally to the work of other engineers, and this understanding helped her to perform her own job better.

Hypothesis 2a: The more extensive the source organization's use of collective teaching activities, the greater the improvement of the receiving organization's stock of individual knowledge.

The differential effects of collective vs. individual teaching on transferring individual knowledge

It is intuitive to expect that individual teaching is the more suitable teaching approach for transferring individual knowledge, just as collective teaching is the more effective teaching approach for transferring collective knowledge. Indeed, in practice, individual teaching is the dominant teaching approach of educational institutions, mainly because it is well suited for teaching decontextualized knowledge (Lave and Wenger 1991). However, most knowledge involved in daily jobs is context-specific. Therefore, one cannot rely solely on decontextualized knowledge to solve complex problems in various contingent situations, because individual skills involve a large amount of contextual knowledge. For example, an engineer may have learned mechanical design from her college classes, but designing a mechanical part in a real job situation requires a large amount of contextual knowledge such as the quality requirement, the design budget, and the availability of various engineering resources of the organization. Collective teaching offers several advantages over individual teaching in conveying the contextual aspects of individual knowledge to the learning individuals. First, compared to individual teaching, collective teaching can provide individuals of the receiving organization with greater exposure to the context that constructs individual knowledge. Second, compared to individual teaching, collective teaching provides more points of reference, and

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thus allows the individuals of a receiving organization to grasp certain knowledge better. Taking the aforementioned example, suppose that the engineer is a member of the receiving organization. She will better acquire the contextual knowledge around mechanical design by working in the design unit of the source organization (i.e., receiving collective teaching by the source community) than receiving individual teaching from an expatriate of the source organization.

In a similar vein, collective teaching (or team teaching) has become increasingly popular among educational institutions because of its many pedagogical and intellectual advantages in teaching individual-based knowledge. It is found that team teaching helps create a dynamic and interactive learning environment, provides instructors with a useful way of modeling thinking within or across disciplines, and provides students with multiple perspectives and a comprehensive view of the whole area. As a result, team teaching helps students to discover interdependence and correlations between subject areas (Buckley, 1999).

Hypothesis 2b: The source organization's use of collective teaching activities has a greater positive impact than does its use of individual teaching activities on the improvement of the receiving organization's stock of individual knowledge.

Collective and individual absorptive capacities

Absorptive capacity is the ability of a firm to recognize valuable outside information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). In the context of knowledge transfer, the recipient organization's absorptive capacity is critical for acquiring and assimilating knowledge from the source organization. In their seminal study on absorptive capacity, Cohen and Levinthal (1990) indicate that *individual absorptive capacity* depends mostly on the individual's preexisting knowledge structure. However, they also point out that '[a] firm's absorptive capacity is not, however, simply the sum of the absorptive capacities of its employees, and it is therefore useful to consider *what aspects of absorptive capacity are distinctively organizational* (Cohen and Levinthal 1990: 131 emphasis added). Obviously, an organization's ability to absorb new knowledge depends not only on the aggregation of the prior knowledge of its employees, but more importantly on distinctively organizational characteristics that are conducive to absorbing new knowledge. We term these as *collective absorptive capacity*.

In order to understand the nature of collective absorptive capacity, we must first examine the challenges involved in an organization's absorbing and adapting new knowledge, since absorption of new knowledge does not happen naturally. These challenges, we believe, mostly lie in two areas: coordination and motivation.[6] An organization's *coordination challenge* of absorbing and adapting new knowledge is rooted in the division of labor and the need for coordination across divisions. Economist Gary Becker (1964) suggests that specialization and division of labor induces difficulties in coordination and communication among members of an organization. Absorbing and adapting new knowledge implies changes in the way individual members think, behave, and conduct productive functions. Moreover, it calls for changes in the way individuals coordinate and communicate with one another. These changes will intensify the coordination and communication challenges within an organization. Therefore, to absorb new knowledge, an organization must use certain mechanisms to overcome the communication and coordination challenges.

An organization also has to motivate its members to learn and absorb new knowledge, since organizational members may be reluctant to do so due to their comfort with the status quo, fear of uncertainty, unwillingness to seek or share knowledge, and their concern about losing privileges attached to the old ways of doing things (Williamson, 1975). In addition, Hannan and Freeman (1989) have suggested that organizations rely on a reproducible structure to ensure reliability in their productive functions. However, the reproducibility of structure generates organizational inertia, which is the resistance to change

[6] Szulanski's study (1996) provides many insights into the challenges associated with knowledge transfer. He found that the barriers to transferring knowledge include both motivation issues and coordination issues. In the motivation aspect, he found that a lack of motivation to adopt new knowledge at the recipient side is positively related to the difficulties experienced throughout the transfer process. In the coordination aspect, he found that the organizational context (such as performance measurement) and the ease of communication between the source and recipient units reduce the barriers to transfer. Therefore, his notion of organizationally embedded barriers is similar to what we called coordination and motivation challenges.

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or the adoption of new knowledge. Therefore, in order for an organization to absorb and adapt new knowledge, it needs certain organizational conditions (i.e., collective absorptive capacity) to overcome the motivational challenges associated with the accompanying changes.

What does collective absorptive capacity actually entail then? Cohen and Levinthal (1990) argue that an organization's absorptive capacity involves communication linkages among organizational members and their ability to share knowledge. In a similar vein, Henderson and Clark (1990) also suggest that the information channels and filters that link the different functions of an organization affect its ability to detect and adapt to technological changes. Clearly, collective absorptive capacity involves communication and information structure, such as its reporting hierarchy, intranet, groupware, and organization-wide IT systems, which all allow prompt knowledge detection, smooth knowledge sharing, and reliable knowledge retention (Youndt, Subramaniam, and Snell, 2004). These structural conditions help to overcome the *coordination* challenges associated with absorbing and adapting to new knowledge.

In addition to these structural conditions, we argue that a firm's culture is an important aspect of collective absorptive capacity, since it may affect the employees' *motivation* to learn and adopt new knowledge. Many studies have found that social relationships and trust among individuals strongly influence their willingness to share, learn, and create knowledge (Collins and Smith, 2006; Nahapiet and Ghoshal, 1998; Subramaniam and Youndt, 2005; Tsai and Ghoshal, 1998). Moreover, organizational culture can foster learning-oriented goals and behaviors among individual managers (Bunderson and Sutcliffe, 2003). Therefore, we suggest that collective absorptive capacity consists of both *structural attributes* that help to overcome the coordination challenges and *cultural attributes* that help to overcome the motivation challenges associated with absorbing and adopting new knowledge.

Clearly, collective absorptive capacity is qualitatively different from individual absorptive capacity. Individual absorptive capacity is the stock of the prior knowledge and experience of individual members, whereas collective absorptive capacity is the communication and information structure as well as organizational culture characterized by collaboration and learning. Collective and individual absorptive capacities are not polar opposites. In fact, they coexist in organizations. Next, we study the effect of collective absorptive capacity on the transfer of collective and individual knowledge, and compare these effects to those of individual absorptive capacity.

Collective absorptive capacity's effect on transferring collective knowledge

An organization's acquisition and absorption of new collective knowledge (such as the coordination routines involved in lean manufacturing and concurrent engineering) involves both coordination and motivation challenges, since this process entails organization-wide changes in the reporting structure, communication channels, mindset, and interpersonal or inter-functional routines (MacDuffie and Helper, 1997; Stieglitz and Heine, 2007). Consequently, these changes will cause not only coordination difficulties, but also inertial resistance (Hannan and Freeman, 1989). For instance, to adopt lean manufacturing practices, a firm not only has to streamline the production process (i.e., inter-functional and interpersonal routines) using the 'pull' approach and *Kanban* system, it also needs to instill the mentality of continuous improvement and waste-minimization among its employees. For example, when NUMMI, a joint venture between Toyota and General Motors, was adopting the lean manufacturing system, it experienced great challenges, ranging from coordination difficulties associated with just-in-time inventory control to the reluctance of the middle managers to give up the 'old GM style' of management (Florida and Kenney, 2000: 295).

Organizations can mitigate or resolve the coordination challenge by using advanced communication and information structures such as online networks, groupware, document tools, and databases (MacDuffie and Helper, 1997; Youndt *et al*., 2004). In addition, a flexible organizational hierarchy also helps to ease the structural inertia and thus facilitate the adoption of new collective knowledge (Lyles and Salk, 1996). Research also has shown that a receiving organization that is free from the restraints of an obsolete structure is more likely to absorb new knowledge from a source organization (Gupta and Govindarajan, 2000). Since the members of the receiving organization may be reluctant to adopt new collective knowledge due to comfort with the status quo, fear of uncertainty, unwillingness to seek or share knowledge, and

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concerns about losing privileges attached to the old ways of doing things, the cultural aspect of collective absorptive capacity is critical for motivating them to accept and adapt to the change associated with the new collective knowledge. Research has shown that a shared vision of the organizational goal, a culture of continuous improvement, a social climate of team collaboration, and trust among members all contribute to the knowledge gained within the recipient community (Collins and Smith, 2006). Face-to-face interaction, shared mental and physical space, and social relationships provide conditions conducive for knowledge sharing, exploitation, and creation (Nonaka and Nishiguchi 2001). Also, human resources practices that encourage teamwork help to overcome employees' unwillingness to seek or share knowledge (Hansen and Nohria, 2004). In summary, a high level of collective absorptive capacity, which is characterized by effective communication and information structures as well as a culture that encourages knowledge seeking and sharing, would overcome the coordination and motivation challenges associated with acquiring new collective knowledge. Therefore, we suggest,

Hypothesis 3a: The greater the receiving organization's collective absorptive capacity, the greater the improvement of its collective knowledge.

The differential effects of collective vs. individual absorptive capacity on transferring collective knowledge

Individual absorptive capacity is the aggregation of the prior knowledge or experiences of the individual members of a recipient community, which account for the recognition, assimilation, and application of valuable external knowledge (Cohen and Levinthal, 1990; Matusik and Heeley, 2005). Intuitively, a greater level of individual absorptive capacity should lead to greater acquisition of collective knowledge. However, research has found that a high proportion of well-trained and experienced experts within an organization does not guarantee conditions conducive to acquiring collective knowledge and may, in fact, cause a negative collective effect if the collaborative climate of the organization is poor (Subramaniam and Youndt, 2005). 'In fact, having fiercely independent experts reluctant to share their ideas with their colleagues may be counterproductive for organizations... unless individual knowledge is networked, shared, and channeled through relationships, it provides little benefit to organizations in terms of innovative capabilities' (Subramaniam and Youndt, 2005: 459). In our exploratory study, there are ample cases in which state-owned firms with rigid hierarchies could not adopt new and more advanced engineering practices, such as lean manufacturing or concurrent engineering, even though they possessed many highly qualified and experienced engineers. In contrast, private firms that have much less experienced engineers but are more flexible in their structure and culture, found it much easier to adopt new engineering practices. Please refer to the Appendix for examples and details. This indicates that structural and cultural aspects of the organization are stronger determinants of the organization's ability to adapt to new practices than are the sum of the individuals' prior knowledge and experience. In other words, collective absorptive capacity plays a more significant role than individual absorptive capacity does in acquiring and adapting new collective knowledge.

Hypothesis 3b: The receiving organization's collective absorptive capacity has a greater positive impact than does its individual absorptive capacity on the improvement of its stock of collective knowledge.

Collective absorptive capacity's effect on transferring individual knowledge

Coordination and motivation challenges also arise when the members of an organization try to learn new *individual knowledge*, such as job skills. In the coordination aspect, when individuals of a recipient organization attempt to learn new individual knowledge from a source organization, poor communication between the source and the recipient organization impedes the knowledge transfer (Szulanski, 1996). In other words, effective information and communication systems between the source and the recipient organizations can help individual members of the recipient organization to access and acquire new knowledge from the source organization more easily and promptly. Meanwhile, an effective knowledge management system within the recipient organization (such as databases and groupware) can help individuals of the recipient

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organization to share, store, and diffuse individual knowledge they have learned from the source organization (Youndt *et al*., 2004).

Regarding motivational aspects, it has long been established in the education literature that individuals need to be motivated to learn (Stipek, 2001). Prior studies have found that organizational culture and the climate of a team can foster learning-oriented goals and behaviors among individual members (Bunderson and Sutcliffe, 2003). Peter Senge (1990) describes a 'learning organization' as an organization in which new and expansive patterns of thinking are encouraged and nurtured, where collective aspiration is set free, and where people are committed to learn. He also points out that many organizations suffer from 'learning disabilities' due to a poor learning orientation. An organizational culture that manages error and risk constructively may also encourage individuals to learn as a result of error detection and analysis (Edmondson, 1999). Strong social capital, that is, interpersonal trust and relationship among members, will motivate organizational members to learn, share, and exchange knowledge (Nahapiet and Ghoshal, 1998). Thus, the motivation aspect of collective absorptive capacity, which involves a learning-oriented and collaborative culture, motivates the members of the recipient organization to absorb and adopt new collective knowledge.

Hypothesis 4a: The greater the receiving organization's collective absorptive capacity, the greater the improvement of its stock of individual knowledge.

The differential effects of collective vs. individual absorptive capacity on transferring individual knowledge

Between individual prior knowledge (i.e., individual absorptive capacity) and the structural and cultural conditions of the receiving organization that are conducive to absorbing new knowledge (i.e., collective absorptive capacity), which has a greater impact on individual learners' acquisition of individual skills? It is conceivable that an individual's prior knowledge is indispensible for him or her to absorb new knowledge. However, it should be noted that the *motivation* to learn is just as important for an individual to learn new knowledge (Stipek, 2001). We believe that collective absorptive capacity is superior to individual absorptive capacity in motivating individuals to learn. In organizations, individuals are embedded in the task structure and social environment of the organization. A strong collective absorptive capacity, characterized by a high level of learning orientation and a good information system, can motivate and enable individual members to apprehend new external knowledge (Jansen, Van den Bosch, and Volberda, 2005). The motivating and enabling effects of collective absorptive capacity are greater than that of the individual absorptive capacity.

Hypothesis 4b: The receiving organization's collective absorptive capacity has a greater positive impact than does its individual absorptive capacity on the improvement of its stock of individual knowledge.

In summary, we have developed a multilevel knowledge transfer framework that hypothesizes asymmetric effects between individual and collective knowledge transfer mechanisms. This framework suggests that all collective-based mechanisms are more effective in transferring both individual and collective knowledge than are their individual-based counterparts.

METHODS

Research setting

We selected the multinational activities involved in transferring engineering capabilities in the Chinese auto industry as the empirical setting for this study. China is one of the world's fastest-growing auto markets. Multinational auto firms have been ramping up their efforts to transfer engineering capabilities to their operations in China, mainly due to the need to adapt their products to local tastes and the increasingly intense competition in the Chinese auto market. Many leading multinational firms, such as General Motors, Volkswagen, and Delphi, have been actively transferring engineering capabilities to their Chinese operations for more than a decade. Engineering capabilities in the automotive industry involve not only individual knowledge, such as individual computer skills, design skills, and testing skills, but also a substantial amount of collective knowledge, such as

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design modification and validation routines that involve coordination among people from different functional areas. The most prevalent engineering task that multinational corporation subsidiaries and joint ventures in the Chinese automotive industry perform is adapting existing product designs to the local conditions, regulations, and consumer tastes. Performing this type of task requires intensive inter-functional coordination among functions such as design, manufacturing, prototyping, testing, validation, and purchasing. As a result, the engineering capabilities that Chinese auto firms are seeking to acquire are heavy in collective knowledge content (Zhao *et al*., 2004).

This empirical setting provides a natural experiment by which to study the phenomenon of knowledge transfer, not only because of the high occurrence of capability transfer activities within this industry, but more importantly, because of the unique asymmetries between the source and the receiving entities. Before the influx of multinational firms in the mid 1980s, the Chinese auto industry was far behind the world standards for technological and managerial capabilities. Therefore, it is safe to say that the majority of the enhancement in engineering capabilities at a receiving organization, that is, joint ventures or wholly owned foreign enterprises, is due to knowledge transfer from its source organization, which is typically its foreign partner or foreign parent firm. In addition, due to the substantial cultural, technical, and managerial differences between receiving organizations in China and multinational source units (Beamish, 1993), we can observe large variance in the mechanism and outcome of knowledge transfer practices.

Sample and data collection

We conducted this study using both exploratory and confirmatory approaches. The exploratory approach provides rich detail, while the confirmatory study provides rigor, structure, and generalizability to the findings. In the exploratory phase, we conducted fieldwork over a period of four years. Through 31 open-ended interviews, 26 in-depth, semi-structured interviews, and field observations in nine international joint ventures in the Chinese auto industry, we identified the relevant multilevel constructs involved in knowledge transfer. We then examined these constructs in further detail and identified some important dimensions through qualitative analysis (Yin, 1994). The qualitative analysis of the field data helped us to define our key constructs and design survey items for measuring these constructs.

In the confirmatory phase of this work, we used a mail survey to measure various constructs and to test our hypotheses. The sampling frame of our survey study is the directory of Chinese automotive firms listed in the *Chinese Automotive Industry Yearbook* (CATRC, 2003). All of the firms included in our sample are receiving organizations for engineering capabilities. We set up a cutoff point of annual revenue at 2.5 million renminbi (RMB) (about 0.3 million U.S. dollars) to ensure that our sample firms were large enough to have engineering activities. Based on this requirement, we selected 398 firms that have a distinct source organization of engineering capabilities. Given the technological and managerial distance between Chinese and foreign automotive firms from more developed countries, technological and managerial knowledge has predominantly flowed from the foreign firms to the firms in China (Zhao *et al*., 2004). Since all of our respondents are from firms located in China, that is, recipient organizations, we asked our respondents to identify a major source organization that transfers technological and managerial knowledge to their organizations.[7]

To ensure the reliability and validity of the survey scales, we consulted literature review, our exploratory fieldwork, and extensive feedback from both the academic and industrial arenas when designing our survey questionnaire. We revised the survey questionnaire five times based on review feedback from strategy scholars and industrial experts. It was also pilot tested by 16 respondents from five joint ventures in the Chinese auto industry. The drafts and the final version of the questionnaire have all been back-translated to ensure that the Chinese translation accurately reflects the meaning of the English version. The final version of the questionnaire contains 144 questions, most of which are measured by a seven-point Likert scale. We sent our survey questionnaire to an average of four managers and chief engineers in the engineering department of each firm in our sample. The respondents of the survey are local managers,

[7] In all of the cases, the respondents whose firms are international joint ventures identified their foreign partners as their source organizations, whereas the respondents whose firms are wholly owned foreign enterprises identified their foreign parents as their source organizations.

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not foreign expatriates. It is a common practice in prior knowledge transfer studies to use knowledge recipients as respondents. This is based on the belief that the local partner generally has a good idea of how far the technology has been properly acquired and implemented in the venture (Simonin, 1991). We acquired the names of the informants by calling each selected firm, using secondary data sources (industry reports and newspaper), or relying on word-of-mouth information from company contacts. Out of the 398 firms to which we sent questionnaires, we received 201 responses from 137 firms. The firm-level return rate was 34.8 percent, which is very satisfactory in comparison to other survey studies carried out in China (e.g., 14.4% in the study of Isobe, Makino, and Montgomery [2000]). Of these responses, there were 161 unique engineering units with unique source organizations. All source-recipient relationships in our sample were at least five years old at the time of the survey, with a mean age of 9.1 years.

Although a full-scale multiple-informant approach is very difficult to implement in China (Li and Atuahene-Gima, 2002), we did manage to achieve a subsample of 25 engineering units to provide multiple responses. Following numerous strategy studies (Ghoshal and Bartlett, 1988; Gupta and Govindarajan, 2000; Jansen *et al*., 2005), we used this subsample to infer the interrater agreement for our full sample. All of the key constructs demonstrated strong interrater agreement, with Pearson's correlations ranging from 0.48 to 0.58 ($p < 0.02$ for all constructs), well above what has been deemed acceptable in prior studies (Ghoshal and Bartlett, 1988; Gupta and Govindarajan, 2000; Jansen *et al*., 2005). This clearly indicates significant interrater agreement. Moreover, because our focus was measuring knowledge transfer practices and the outcomes of an organization as a whole, we relied on the bird's-eye view of the managers, who served as key informants (Capron, Dussauge, and Mitchell, 1998; Subramaniam and Venkatraman, 2001).

To test for nonresponse bias, we examined the difference between the size of the samples of respondents and nonrespondents, using the archival data for the total number of full-time firm employees in the *Chinese Automotive Industry Yearbook* (CATRC, 2003). A two-tailed t-test showed no significant difference ($p = 0.54$) between the two groups. In addition, we checked for common method bias using Harman's one-factor test. A principal factor analysis of all measurement items yielded 10 factors with eigenvalues larger than one. These factors accounted for 72.9 percent of the variance. Since no single factor emerged as dominant, common method variance is unlikely to be a serious problem in the data (Podsakoff and Organ, 1986).

Variables

Collective teaching and individual teaching

To measure the extent to which a source organization implements a certain teaching strategy, we focused on the degree of 'regularity' of the application of this strategy from the onset of the source-recipient relationship (Kale, 1999). Because most of the teaching activities in educational settings are evaluated by students and not by teachers, we relied on the respondents from the receiving organization to evaluate the extent of teaching provided by the source organization. Furthermore, because collective teaching is a novel concept, we selected four items that span the concept domain of collective teaching, based on interviews with the practitioners as well as research on knowledge transfer (Almeida and Grant, 1998; Florida and Kenney, 2000; Inkpen and Dinur, 1998; Subramaniam and Venkatraman, 2001). Two items describe how routinely the source organization involves members of the receiving organization in its field of interaction through various approaches, such as joint projects and cross-functional meetings. The other two items ask more directly the extent to which the members of the receiving organization were exposed to the interrelational coordination among members of the source organization when solving complex problems or carrying out a technical project. We developed a two-item scale to measure the construct of individual teaching based on the research of Almeida and Grant (1998). These items involved how routinely the source organization arranges for experts to teach technical skills to the members of the receiving organization, whether it is carried out in a classroom setting or through on-site technical assistance.

Collective absorptive capacity and individual absorptive capacity

The concept domain of collective absorptive capacity includes structural and cultural features of

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the receiving organization that are conducive to knowledge absorption. We designed five items to span this concept domain, based on our fieldwork and several relevant studies (Badham, Couchman, and Zanko, 2000; Bunderson and Sutcliffe, 2002; Gupta and Govindarajan, 2000; Lyles and Salk, 1996; Matusik and Heeley, 2005). Two items inquire about the extent to which the receiving organization's structure is open and flexible. Two items ask about the extent to which the knowledge infrastructure of the receiving organization is effective. Another item focuses on the level of team orientation of the receiving organization. Individual absorptive capacity refers to the relevant prior knowledge base of the individual members of the receiving organization (Lane and Lubatkin, 1998; Matusik and Heeley, 2005; Simonin, 1991). To assess the overall individual absorptive capacity of the receiving organization, we designed two items that ask the respondent to take stock of the percentage of the engineers in his or her organization who have received training in two key areas of engineering tasks: product design and project management, with one = 0 percent, four = 50 percent, and seven = 100 percent.

Collective knowledge and individual knowledge

We used two dependent variables to measure the outcomes of capability transfer: the improvement in the receiving organization's stock of individual knowledge and its stock of collective knowledge during the past three years. The concept domain of collective knowledge involves knowledge embedded among organizational members of how to coordinate, share, distribute, and recombine individual knowledge. Since few previous studies have measured improvement in an organization's stock of collective knowledge, we developed a four-item scale to measure this concept based on relevant theoretical discussions (Grant, 1996; Kogut and Zander, 1992; Nelson and Winter, 1982). These items concern the receiving organization's overall improvement of the common mindset and culture, as well as interrelational knowledge such as coordination routines and the ability to apply advanced cross-functional technical procedures. The first two items were related to interfunctional and interpersonal communication and coordination ability among employees. The last two items concerned the norms commonly shared among employees. We measured the receiving organization's improvement in individual knowledge with a three-item scale based on Lyles and Salk (1996), which involves the overall improvement in technical knowledge, project management skills, and necessary job-related competencies of the receiving organization's employees.

Control variables

We also included control variables such as the source organization's nationality, the size of the receiving organization, and the prior performance of receiving firms. The source organization's nationality is related to the cultural and technological distance between the source and receiving organization and may therefore affect the outcome of knowledge transfer (Mowery *et al*., 1996). The size of the receiving organization may influence its collective absorptive capacity, since larger organizations are usually more hierarchical and less adaptive. We adopted the scaling scheme from the *Chinese Auto Industry Yearbook* (CATRC, 2003) to categorize firm size by seven levels, based on the total number of employees: Level 1 = less than 300 employees, Level 2 = 301 to 500 employees, Level 3 = 501 to1,000 employees, Level 4 = 1,001 to 3,000 employees, Level 5 = 3,001 to 5,000 employees, Level 6 = 5,001 to 10,000 employees, and Level 7 = 10,001 and above employees. The prior performance of the receiving organization is related to the availability of slack resources, which could support knowledge transfer efforts (Subramaniam and Youndt, 2005). We measured this construct based on four subjective performance indicators in the year before the survey, that is, year-to-year increase of sales, profit, and market share, as well as overall competitiveness.

Measurement validity

As shown in Table 2, the reliability values (Cronbach α) of all constructs are above the cutoff value of 0.70 suggested by Nunnally (1978), ranging from 0.78 to 0.89. To examine the convergent validity of all constructs, we calculated the factor loadings of each indicator in the measurement model, which includes all latent constructs and their indicators, using AMOS 7.0 (Anderson and Gerbing, 1988). As presented in Table 2, the standardized factor loadings of all indicators in our model are above 0.59 ($p < 0.001$), greater than the threshold value of 0.40, indicating sufficient

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Table 2. Measurement of latent constructs

	Survey items	Standardized estimates[a]	Cronbach α
Collective teaching			0.89
CT1	Our partner[c] involved us in their cross-functional meetings	0.78	
CT2	Our partner involved us to carry out joint projects with its employees	0.84	
CT3	Our partner demonstrated to us how its employees resolve cross-function issues as a team	0.86	
CT4	Our partner demonstrated to us how its employees jointly plan and carry out a technical project	0.80	
Individual teaching			0.88
IT1	Our partner arranged experts to teach technical skills to our employees	0.75	
IT2	Our partner provided individual technical assistance to our employees	1.00	
Collective absorptive capacity			0.82
CAC1	We maintained a low level of vertical hierarchies and cross-function barriers in the organization structure	0.61	
CAC2	We have been adaptive and flexible to structural changes aimed at improving work efficiency	0.65	
CAC3	We adopted the team-based performance appraisal and compensation human resources system	0.59	
CAC4	We adopted an excellent information infrastructure for employees to share information and knowledge	0.74	
CAC5	We maintained an expertise directory of job division and specialty of all employees	0.86	
Individual absorptive capacity			0.78
IAC1	The percentage of our organization's members who have gone through trainings in project management	0.73	
IAC2	The percentage of our organization's members who have gone through trainings in product or process design	0.87	
Collective knowledge[b]			0.86
CK1	The coordination ability among our employees has improved	0.79	
CK2	The ability of cross-function communications among our employees has improved	0.80	
CK3	The commonly shared norm for continuous learning and improvement among our employees has improved	0.72	
CK4	The commonly shared norm for teamwork and resource sharing among our employees has improved	0.82	
Individual knowledge[b]			0.78
IK1	Our employees' grasp of advanced technological knowledge in their specialties has improved	0.77	
IK2	Our employees' competencies in conducting their tasks have improved	0.71	
IK3	Our employees' project management skills have improved	0.74	
	Chi sq (df)	261.46 (155)	
	CFI	0.93	
	IFI(delta2)	0.93	
	RMSEA	0.066	

[a] All estimates are significant at $p < 0.001$
[b] The time frame for questions items related to collective knowledge and individual knowledge is between 2002 and 2004
[c] The word 'partner' in this questionnaire means the source organization, which may either be the foreign partner if the responding firm is a joint venture, or the foreign parent if the responding firm is a wholly owned foreign enterprise

convergent validity (Ford, MacCallum, and Tait, 1986). The measurement model fits very well with the data (chi-square = 261.46, df = 155, RMSEA = 0.066, CFI = 0.93), indicating good construct validity of all latent variables.

Because discriminant validity between individual- and collective-based constructs is the foundation of this study, we used several approaches to check it thoroughly. First, we performed factor extraction to see whether indicators pertaining to

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different constructs would land on separate factors. Rotated component loading, as shown in Table 3, clearly indicates that all constructs are orthogonally distinct from each other. We then conducted pairwise evaluations on all possible pairs of constructs in our model using two criteria. The first criterion was that the 95 percent confidence interval of the correlation for every pair of constructs should not include one (Anderson and Gerbing, 1988; Bagozzi and Phillips, 1982). The second criterion was that the average shared variance coefficient of each construct should be greater than the squared correlation between this construct and any other construct in the model (Fornell and Larcker, 1981). All pairs of constructs in this study passed these tests of discriminant validity.

The results of the above tests not only prove that the survey scales are reliable and valid, but also more importantly demonstrate that the distinction between individual and collective knowledge transfer mechanisms, such as teaching and absorptive capacities, indeed exists, both theoretically and empirically.

RESULTS

Table 4 shows the descriptive statistics for each construct and correlations among them. We chose structural equation modeling (SEM) to test our hypotheses, because our proposed model has two simultaneous dependent variables and multiple indicators for each latent variable. SEM is appropriate, based on its strength in accommodating multiple dependent variables in one structural model, while accounting for measurement errors of the indicators (Anderson and Gerbing, 1988).

To ensure a solid specification of the structural model, we first used hierarchical ordinary least square regression to test the effects of independent and control variables on two dependent variables

Table 3. Rotated component analysis for discriminatory validity[a,b,c]

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Collective teaching						
CT1	0.79	0.20	0.06	0.08	0.23	0.04
CT2	0.83	0.09	−0.02	0.22	0.10	0.21
CT3	0.88	0.07	0.12	0.13	0.11	0.08
CT4	0.81	0.16	0.09	−0.01	0.13	0.19
Individual teaching						
IT1	0.16	0.91	0.02	0.05	0.13	0.06
IT2	0.27	0.85	0.12	0.06	0.08	0.21
Collective absorptive capacity						
CAC1	0.11	0.12	0.64	0.16	0.30	−0.14
CAC2	−0.06	0.02	0.67	0.11	0.20	0.28
CAC3	0.05	0.19	0.80	0.02	−0.02	0.11
CAC4	0.12	−0.16	0.81	0.09	0.14	0.10
CAC5	0.13	0.06	0.73	0.03	0.46	0.05
Individual absorptive capacity						
IAC1	0.12	0.07	0.14	0.89	0.09	0.10
IAC2	0.22	0.04	0.12	0.83	0.19	0.10
Collective knowledge						
CK1	0.26	0.20	0.29	0.06	0.66	0.14
CK2	0.02	0.07	0.19	0.10	0.77	0.30
CK3	0.20	0.07	0.11	0.17	0.82	0.15
CK4	0.17	0.02	0.22	0.06	0.83	0.06
Individual knowledge						
IK1	0.41	0.24	0.03	0.12	0.23	0.66
IK2	0.48	0.10	0.23	0.22	0.12	0.55
IK3	0.19	0.11	0.21	0.08	0.40	0.73

[a] Rotation converged in six iterations
[b] Extraction method: principal component analysis
[c] Rotation method: Varimax with Kaiser normalization

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Table 4. Descriptive statistics and Pearson correlations[a,b]

	Mean	S.D.	1	2	3	4	5	6	7
1. Collective teaching	3.76	1.56							
2. Individual teaching	4.05	1.51	0.41**						
3. Collective absorptive capacity	5.15	1.03	0.23**	0.20*					
4. Individual absorptive capacity	4.10	1.54	0.34**	0.21**	0.29**				
5. Collective knowledge	5.17	0.92	0.41**	0.31**	0.53**	0.30**			
6. Individual knowledge	4.87	0.97	0.61**	0.42**	0.40**	0.38**	0.58**		
7. Prior performance	4.60	1.13	0.27**	0.20*	0.13	0.02	0.12	0.35**	
8. Size	3.50	1.88	−0.11	−0.16	−0.25**	−0.08	−0.04	−0.12	−0.14

[a] N=161; †$p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed)
[b] All constructs in this table are on a scale of 1 to 7

Table 5. Results of regression analysis[a,b]

Variables	DV = Individual knowledge			DV = Collective knowledge		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Source organization's nationality	−0.23**	−0.09	−0.05	−0.21*	−0.10	−0.03
Recipient organization's size	−0.08	−0.03	−0.03	−0.03	0.01	0.12
Recipient organization's prior performance	0.34***	0.21**	0.22***	0.09	−0.01	−0.09
Individual teaching		0.18*	0.15*		0.17†	0.12
Collective teaching		0.45***	0.37***		0.32***	0.22***
Individual absorptive capacity			0.17*			0.10
Collective absorptive capacity			0.20**			0.45***
Model F	11.41***	22.56***	21.53***	2.76*	6.63***	12.33***
Adjusted R^2	0.19	0.45	0.52	0.04	0.17	0.37
F-value for Change in R^2		31.35***	10.59***		11.75***	21.37***

[a] The entries in this table are all standardized estimates
[b] N=161; † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed)

separately. Before the regression analyses were performed, we checked for multicolinearity. The results demonstrated that the extent of multicolinearity was well within the acceptable range. The tolerance values for all explanatory variables were within the range of 0.66 and 0.90, well above the cutoff value of 0.1, and the variance inflation factor values of these variables were within the range of 1.11 and 1.51, well below the cutoff value of 10 (Hair *et al*., 1995). We also checked for univariate normality by performing a modified Kolmogorov-Smirnov test (Hair *et al*., 1995). All variables demonstrated normal distribution.

Table 5 presents the results of the regression analysis. The estimates in Models 4, 5, and 6 provide strong support for Hypothesis 1a and Hypothesis 3a. Both collective teaching and collective absorptive capacity have a significant positive relationship with the collective knowledge gained by the receiving organization, whereas individual teaching and individual absorptive capacity do not make a significant contribution to the transfer of collective knowledge. The results of Models 1, 2, and 3 in Table 5 strongly support Hypothesis 2a and Hypothesis 4a. Both collective teaching and collective absorptive capacity have a significant positive relationship with the transfer of individual knowledge. Although individual teaching and individual absorptive capacity also relate positively to the transfer of individual knowledge, the extent of their contribution is much smaller and less significant than that of their collective-based counterparts, that is, collective teaching and collective absorptive capacity.

We evaluated the four comparative hypotheses, namely Hypothesis 1b, 2b, 3b, and 4b, by comparing the estimates of relevant coefficients using a two-sample t-test. Each hypothesis is strongly supported at the $p < 0.001$ level, indicating superiority of collective teaching and collective absorptive capacity over their individual-based counterparts in transferring both collective and individual

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knowledge. To be specific, the effect of collective teaching on the receiving organization's gain of collective knowledge is significantly greater than that of individual teaching ($t = 15.51$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 1b; the effect of collective teaching on the improvement of individual knowledge is significantly greater than that of individual teaching ($t = 37.72$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 2b; the effect of collective absorptive capacity on the improvement of collective knowledge is significantly greater than that of the individual absorptive capacity ($t = 49.84$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 3b; and the effect of collective absorptive capacity on the improvement of individual knowledge is significantly greater than that of the individual absorptive capacity ($t = 20.56$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 4b. The results show that none of the control variables have a significant effect on the two dependent variables, except for the prior performance of the receiving organization, which is significantly related to the transfer of individual knowledge.

Based on the results of the regression analysis, we delineated the structural model, which links all four explanatory variables (i.e., collective and individual teaching and collective and individual absorptive capacity) with the two dependent variables (i.e., collective and individual knowledge transferred). The structural model fits well with the data (chi-square $= 322.0$, df $= 175$, IFI $= 0.91$, CFI $= 0.91$, RMSEA $= 0.07$). Table 6 presents the parameter estimates of the structural model.

Hypothesis 1a receives strong support, based on the significant and positive relationship between collective teaching and improvement in collective knowledge (standardized estimate $= 0.27$, $p < 0.001$). Collective teaching activities also display a significantly positive effect on improvement in individual knowledge (standardized estimate $= 0.51$, $p < 0.001$), strongly supporting Hypothesis 2a. Hypothesis 3a is strongly supported, as seen in the significantly positive relationship between collective absorptive capacity and improvement in collective knowledge (standardized estimate $= 0.55$, $p < 0.001$). Hypothesis 4a is strongly supported, based on the significantly positive relationship between collective absorptive capacity and improvement in individual knowledge (standardized estimate $= 0.28$, $p < 0.001$).

We tested the four comparative hypotheses, namely Hypothesis 1b, 2b, 3b, and 4b, by comparing the relevant path coefficients using a two-sample t-test. All hypotheses receive strong support at the $p < 0.001$ level, confirming the findings of our regression analysis. Specifically, the effect of collective teaching on the receiving organization's gain in collective knowledge is significantly greater than that of individual teaching ($t = 18.42$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 1b; the effect of collective teaching on the improvement of individual knowledge is significantly greater than that of individual teaching ($t = 42.38$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 2b; the effect of collective absorptive on the improvement of collective knowledge is significantly greater than that of individual absorptive capacity ($t = 33.83$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 3b; and the effect of collective absorptive capacity on the improvement of individual knowledge is significantly greater than that of individual absorptive capacity ($t = 15.28$, df $= 320$, $p < 0.001$), strongly supporting Hypothesis 4b.

In summary, all hypotheses receive strong support from both the regression analysis and SEM.

Table 6. Structural model: parameter estimates

Construct relationship	Standardized estimate	Critical ratio	p-value
Collective teaching → individual knowledge (Hypothesis 2a)	0.51	5.02	<0.01
Individual teaching → individual knowledge	0.19	2.32	0.02
Collective absorptive capacity → individual knowledge (Hypothesis 4a)	0.28	3.52	<0.01
Individual absorptive capacity → individual knowledge	0.15	1.57	0.12
Collective teaching → collective knowledge (Hypothesis 1a)	0.27	2.86	<0.01
Individual teaching → collective knowledge	0.05	0.58	0.56
Collective absorptive capacity → collective knowledge (Hypothesis 3a)	0.55	5.86	<0.01
Individual absorptive capacity → collective knowledge	0.07	0.73	0.47

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As shown in Tables 4 and 5, the results of these two analytical approaches are consistent in both the standardized estimates and the significance levels of coefficients. This provides confidence in the robustness of our findings.

DISCUSSION AND IMPLICATIONS

Theoretical contributions

Collective organizational phenomena are fundamentally different from the aggregation of individual phenomena within an organization. However, the traditional multilevel approach treats both of these categories of concepts as organizational-level concepts and thus obscures their differences. Strategy and organizational research has just begun to make headway into the understanding of collective phenomena as a separate category of concepts from the aggregation of individual phenomena (March, 1996; Murmann *et al*., 2003). In this study, we have tried to build on this groundbreaking research by making two important contributions to multilevel research and the knowledge transfer literature.

First, we found that, contrary to the common implicit epistemological presumption, teaching and absorptive capacity both exist at the collective level. The organizations in our study used varying extents of both the individual and the collective forms of teaching in their knowledge transfer activities. A firm's absorptive capacity not only involves individual members' prior knowledge and experience, but also has to do with the firm's structure and culture, which are conducive to knowledge absorption.

Second, and more importantly, by simultaneously testing the within-level and cross-level effects of teaching and absorptive capacity on the transfer of individual and collective knowledge in one model, we provide compelling evidence that collective-based knowledge transfer mechanisms, such as collective teaching and collective absorptive capacity, are more effective in transferring knowledge compared to their individual-level counterparts. The findings of this study not only reveal a strong differential benefit of collective teaching and absorptive capacity in transferring collective knowledge, but also offer striking evidence that collective teaching and collective absorptive capacity are more effective in transferring individual knowledge than are their individual counterparts. This asymmetry between the collective and individual constructs confirms the prevailing view that higher level constructs usually exert a strong downward influence to the lower level variables (Hitt *et al*., 2007). Our study verifies theoretically and empirically the need for and the importance of applying a multilevel and holistic approach to understand organizational phenomena such as knowledge transfer.

Practical implications

Previous research has documented the difficulty in transferring knowledge within firms (Szulanski, 1996). Such challenges are particularly important for multinationals and their international joint ventures and subsidiaries, and for emerging economies. Our research approach has important implications for the understanding of multinationals and their ability to transfer their knowledge to foreign subsidiaries (Kogut and Zander, 1992). It also helps understand the challenges of transferring knowledge to firms in emerging economies in general, and through joint ventures and multinational subsidiaries in particular. The value of our findings is highlighted by the general lack of emphasis on collective teaching and learning among multinationals and their partners in our study.

The findings of this study appeared to be counterintuitive to the many practitioners we interviewed, who usually focus more on the individual aspects of knowledge transfer efforts rather than on the collective aspects. This study assists managers in three areas. First, this study reminds managers that capabilities reside not only in documents, drawings, and the sum of individual skills, but more importantly in collective knowledge. Absent the understanding that collective knowledge is the most important, and yet most difficult part of the capability they try to acquire, the managers we interviewed tended to focus more on transferring individual skills. Maintaining an inventory of individual skills and developing training plans for individual employees have been the widespread practices among firms in the United States, China, and elsewhere. This study suggests the necessity of an explicit approach for measuring, transferring, and developing collective knowledge. Secondly, this study revealed that the much-ignored collective teaching activities are actually

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more effective than individual teaching activities in transferring both collective and individual knowledge. However, in practice, the managers we surveyed and interviewed appeared to lack an understanding of the importance of collective teaching, and, as a result, placed heavier emphasis on individual teaching mechanisms, such as requesting technical assistance or training by the individual expatriates of their source organizations. A two-sample t-test between the mean values of collective and individual teaching shows that firms in our study used significantly less collective teaching than individual teaching ($t = 9.42$, $df = 320$, $p < 0.001$). This study, however, suggests that managers of receiving organizations should request more collective teaching from their source organizations. Lastly, our findings related to collective vs. individual absorptive capacity also reveal a blind spot in the common staffing practices in the field. The managers we interviewed usually put greater emphasis on the importance of hiring people with good training and experience than on developing a structure and culture conducive to knowledge acquisition and absorption. This study, however, suggests that having a group of highly experienced or well-trained personnel does not guarantee that the group will acquire new capabilities more quickly or effectively. Developing a flexible and adaptive structure and cohesive team culture is more important for the success of capability transfer. In fact, an overemphasis on individual absorptive capacity may have a negative effect on the organization (Murmann *et al*., 2003; Subramaniam and Youndt, 2005).

In summary, without the understanding of the individual-collective distinction, managers are prone to invest mainly in individual teaching and individual absorptive capacity and, as a result, to miss out on the more effective aspects of collective teaching and collective absorptive capacity. We hope that the results of this study will encourage practitioners to pay attention to collective knowledge and collective-based knowledge transfer mechanisms.

Limitations and future research

Since our study focuses on the transfer of firm-specific knowledge in the context of a single host country, we cannot evaluate any location-specific effects. In addition, prior knowledge transfer research has suggested a broad range of factors that may influence the outcome of knowledge transfer efforts. Given our limited sample size, we cannot include all of them in this study. Another limitation of this research lies in its cross-sectional design, which may entail endogeneity of firm-specific factors. We try to remedy this issue by making sure that the time span underlying our explanatory variables, that is, the age of the source-recipient relationships in our sample, is longer than the time span in which the improvement of knowledge stock is evaluated. In our sample, the minimum length of the source-recipient relationship is five years at the time of the survey and the average length is 9.1 years; whereas the time span we asked the respondents to use to evaluate the improvement of their knowledge stock is three years. Although still less rigorous than a longitudinal design, this remedy at least provides some time span difference between the explanatory and the outcome variables.

A potential extension of this study could include an examination of the distinction between the collective and the aggregation of individuals in other organizational constructs, such as teaching motivation and learning motivation. Moreover, it is worth noting that, while we emphasize the severely understudied collective aspect of knowledge transfer constructs, we do not discredit the role of individual attributes and effort. After all, individuals from the foundation of the collective, in other words, collective phenomena, would not exist unless the individuals who make up the collective make their own unique individual efforts. It would be interesting to study which sequence of collective and individual teaching activities is the most effective and efficient in transferring firm capabilities.

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APPENDIX: EXAMPLES OF COLLECTIVE TEACHING AND COLLECTIVE ABSORPTIVE CAPACITY

(Based on field data collected in 2002 by the first author)

Collective teaching

Shanghai-Volkswagen's overseas training program, which cost 1.8 million German marks, provides a good example of collective teaching. The goal of this project was the development of state-of-the-art engineering capabilities that would span all stages and aspects of the vehicle development process. The program involved a team of 41 young managers and engineers, whom Shanghai-Volkswagen's human resources department selected on the basis of skills and communication ability. Twenty managers of this group went to Germany for training in August 1998. A second group of 21 trainees went to Germany in September 1999. In Germany, each trainee first engaged in a six-month study of the German language and his or her own specialty in a German university. They then transferred to Volkswagen AG's vehicle development department to receive training from a team of Volkswagen personnel. As part of the training, the teachers involved them in engineering projects including development of complete vehicles, styling, chassis, engine, and body, as well as computer-related projects. Many of the capabilities required for these projects involved extensive tacit and group-embedded information, making them prime examples of collective knowledge. This on-the-job training in Germany lasted for one year. Afterward the trainees returned to Shanghai-Volkswagen and worked on local projects for a year. After that, they returned to Volkswagen AG in Germany to finish the last half-year of the three-year training program, again working with teams of Volkswagen managers and engineers.

Collective absorptive capacity

In the mid-1980s, none of the state-owned automotive firms in China had efficient information or communication infrastructures to conduct vehicle design. Having been under the centrally controlled system for more than three decades, these firms were also plagued by obsolete managerial styles and organizational cultures characterized by poor collaboration and low initiative for improvement. In effect, the collective absorptive capacity of these firms was very poor even though they were desperate for acquiring advanced technological and managerial knowledge. When the foreign multinational automotive firms began to enter China between the mid-1980s and early 1990s, they had to form joint ventures with local automotive firms due to regulation by the Chinese government. Some international joint ventures were established as a Brownfield operation, where they adopted a large portion of the Chinese partner's existing facility and personnel. However, a few joint ventures took a more Greenfield approach by establishing their own facilities and hiring new personnel. Among the joint ventures we studied in 2002, The Pan Asia Technical Automotive Center (PATAC), China's first automotive engineering and design joint venture—a 50-50 joint venture between General Motors and Shanghai Automotive Industry Corp. Group established on 12 June 1997—is considered a Greenfield operation. Its engineers were mostly new graduates from colleges and, thus, were the least experienced. In other words, the individual absorptive capacity of PATAC is probably the lowest among the joint ventures we studied. However, it did not inherit the obsolete organizational hierarchy and mentalities from its Chinese partner. While conducting a field study on PATAC, the first author was impressed by its advanced information and communication infrastructure as well as its vibrant, open, and collaborative corporate culture.

As a contrast to PATAC, Beijing Jeep—a 50-50 joint venture established by American Motors and Beijing Automotive Industry Holding Corp. in 1983—is a Brownfield joint venture, and had the most experienced engineering personnel at the individual level. However, its personnel were mostly relocated from the Chinese partner. It was inevitable that this large transfer of personnel brought the inefficient organizational hierarchy and culture to the joint venture. In other words, compared to PATAC, Beijing Jeep's individual absorptive capacity was better, yet its collective absorptive capacity was poorer. Our field work of these two joint ventures showed that PATAC was much faster in adopting advanced research and development (R&D) procedures, which is largely collective knowledge with many interpersonal and interfunctional routines. In the second year since its founding, PATAC had already unveiled its first

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concept car, Qilin. Since then, PATAC has successfully designed or localized many car models. This indicates that PATAC acquired a large amount of collective and individual knowledge in vehicle design from General Motors in a short period of time.

In comparison, Beijing Jeep was much slower in adopting new R&D knowledge from its American partner. Until the 1990s, the vehicles produced by this venture still utilized three-speed manual transmissions. Hardly any new models have been designed, let alone commercialized. Twenty years after its founding, it suffered a large turnover of its elite design engineers frustrated by its inefficient managerial style and corporate culture. These findings indicate that individual and collective absorptive capacities are two different concepts, and collective absorptive capacity is more critical than individual absorptive capacity in knowledge transfer.

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