

Toward a Multilevel Knowledge Transfer Paradigm: Capability Transfer in the Chinese Auto Industry

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Abstract

Group-level knowledge is the most valuable yet ‘stickiest’ element of a firm’s capabilities. The effective transfer of group-level knowledge is the key to the success of capability acquisition. Despite its strategic importance, group-level knowledge and its transfer process are still largely under-explored. One of the critical causes for this lack of research is that the traditional knowledge transfer paradigm, assuming a unitary-level perspective on the knowledge transfer outcome and key determinant constructs, does not provide a resolution sharp enough to identify the factors that affect the transfer of group-level knowledge. In this study, I expand the knowledge transfer paradigm from a unitary-level structure into a two-level construction by making conceptual distinctions between the two ontological levels (i.e. individual- vs. group-level) of the key constructs of this paradigm, such as learning strategies, teaching strategies and absorptive capacity. By taking this multilevel perspective, I am able to zoom in on the group-level knowledge content within a firm’s capabilities and gain insight into the ways in which group-level knowledge is transferred. Based on prior literatures and my own exploratory fieldwork, I posit that group-level learning is more effective than individual-level learning in transferring group-level knowledge; group-level teaching surpasses individual-level teaching in transferring individual-level knowledge; and group-level absorptive capacity is the only level of absorptive capacity that contributes to the acquisition of group-level knowledge.

I empirically tested my hypotheses by surveying Chinese automotive firms on their efforts and outcomes when acquiring engineering capabilities from various sources. The findings have validated the conceptual distinctions between the two ontological levels of the key constructs and supported most of the hypotheses. The most striking implication of this study is that in the absence of conceptual distinctions between individual- and group-level knowledge transfer strategies and absorptive capacity, most firms have been overly relying on individual-level teaching and learning strategies and individual-level absorptive capacity, which unfortunately are not the most effective methods for transferring group-level knowledge. It is hoped that the theoretical establishment and empirical findings of this study will encourage firms to choose knowledge transfer approaches and build absorptive capacity in a more effective way.

Keywords: knowledge transfer, organizational capabilities, multilevel perspective, teaching, learning, absorptive capacity, knowledge-based view.

Introduction

A growing number of management theorists and practitioners have proclaimed for decades that the sustainable competitive advantage of a firm can be attributed to the ownership of the firm's capabilities, which are particular forms of organizational knowledge that account for the organization's ability to perform and extend its characteristic "output" actions (Barney, 1986; Dosi, Nelson, & Winter, 2000; Richardson, 1972; Wernerfelt, 1984). In order to survive ongoing external competition, firms continually strive to acquire new capabilities and leverage extant capabilities. The movement of capabilities, be it inflow or outflow, has increasingly become a salient factor underlying the objective and success of a wide range of business strategies, such as foreign direct investment, merger and acquisition, and formation of joint ventures, and has attracted increasing attention in academia (Ahuja, 2001; Anand, 1997; Capron & Mitchell, 1999).

Unfortunately, despite the high rewards companies may receive when capabilities are leveraged appropriately, the track record of corporate diversification and internal transfer of best practices has been poor. In a survey of 431 organizations done by Ruggles (Ruggles, 1998), only 13% of the respondents considered their internal process of knowledge transfer satisfactory. The complexity involved in transferring capabilities from one place to another is often underestimated by managers and even theorists (Collis & Montgomery, 1995). The main research question of this study is: What are the causal mechanisms for transferring capabilities?

A major cause of the high failure rate in capability transfer, according to prior literature and my own fieldwork, lies in the lack of understanding of the nature and transfer mechanisms of the most valuable and yet stickiest knowledge component of capabilities – group-level knowledge, which is a distinct higher-order knowledge embedded among a group of individuals

regarding how to coordinate, share, distribute, and recombine individual-level knowledge (Cook & Brown, 1999; Kogut & Zander, 1992; Spender & Grinyer, 1996b).

Group-level knowledge is valuable, as implied by the resource-based view, because it facilitates the integration and recombination of individual-level knowledge residing in various members of the organization (Kogut et al., 1992). Moreover, group-level knowledge is relatively secure since it is hard for competitors to imitate (Amit & Schoemaker, 1993; Dierickx & Cool, 1989). Failure to transfer the group-level knowledge content means failure to transfer the overall capabilities.

However, group-level knowledge is also difficult to be transferred into intended uses in new areas (Argote, Ingram, Levine, & Moreland, 2000; Cook et al., 1999; Kogut et al., 1992; Prochno, 2003; Spender et al., 1996b), just as it is hard to be imitated by competitors.

Transferring group-level knowledge is difficult not only because it is embedded among many people, but also because group-level knowledge is more stable; and thus a set of obsolete group-level knowledge is more difficult to be unlearned at the recipient's side (Cohen & Bacdayen, 1994). Moreover, the group-level knowledge of the source organization almost always has a significant portion of context-specific element, so to transfer group-level knowledge, one must first tease out the generic element from the context-specific element of group-level knowledge.

Unfortunately, despite the importance and difficulty of transferring group-level knowledge, there is a significant lack of study in the nature and transfer mechanisms of group-level knowledge (Spender & Grant, 1996a). This apparent gap is largely due to a lack of appropriate theoretical wherewithal. Over the past few decades, knowledge-based studies have gradually worked toward a broad framework of knowledge transfer, which includes key determinants to knowledge transfer, such as learning strategies, teaching strategies, absorptive

capacities, teaching and learning motivations. However, the main direction of this stream of research seems to be the expansion of the framework's *scope* by adding more and more explanatory factors. What is seriously missing, though, is the realization and development of the framework's *ontological levels*, which distinguish group-level knowledge transfer mechanisms and outcomes from their individual-level counterparts.

The well-received unitary-level knowledge transfer framework reflects a common assumption underlying the conceptualization of human knowledge and human actions, that individuals are the primary repository of knowledge and the main executor of actions. This preoccupation with individual-level perspective, unfortunately, has impaired our understanding of the reality (Weick & Roberts, 1993). In fact, what truly matters more for an organization is the group-level constructs that reflect interdependencies among people (Thompson, 1967) and the ways in which people with different specialties interrelate, interact, and recombine their knowledge to generate value (Kogut et al., 1992), because interdependencies and integrations are the main reasons for organizations to exist in the first place (Conner & Prahalad, 1996). The systemic and inter-relational features of an organization, such as architectural knowledge (Henderson & Clark, 1990) and routines (Nelson & Winter, 1982), are beyond the aggregation of individual traits and actions, and should be considered as group-level concepts. The traditional knowledge transfer framework, absent of the ontological distinction, stays at unitary-level. More specifically, it assumes individual-level perspective, and thus is incapable of investigating the transfer of group-level knowledge. The lack of understanding of multilevel perspective of knowledge and knowledge transfer mechanisms is a main cause for persistent high failure rate in capability transfer.

In this study, through both exploratory and confirmatory work, I contribute to the knowledge-based view by shifting the academic attention from expanding the *scope* of knowledge transfer framework to examining the *ontological levels* of this framework. Specifically, I investigate key concepts of the knowledge transfer framework, such as teaching and learning strategies, and absorptive capacity at both individual and supra-individual levels (for simplicity, I call the latter group-level).

Further, I develop a multilevel knowledge transfer framework by integrating two levels of teaching strategies, learning strategies, and absorptive capacity into a framework with teaching and learning motivations as antecedents and two levels of knowledge gain as the dependent variables. A set of testable hypotheses underlying this framework are developed based on prior literature and my exploratory work. This multilevel framework provides fine-grained understanding of causal mechanisms of the transfer of group-level knowledge. I empirically examine the validity of the ontological distinctions of the key concepts and test hypotheses by surveying Chinese automotive firms on their efforts and outcomes when acquiring engineering capabilities from external sources.

Theoretical Framework and Hypotheses

For clarity and simplicity, I study capability transfer where there is a source community, which holds a set of desirable capabilities, and a recipient community, to which the capabilities will be transferred.

Capabilities contain three types of knowledge: (a) *individual specialties*; (b) *common knowledge* shared by all members of the organization, such as engineering language and literacy (Grant, 1996), collective mind (Weick et al., 1993), shared cognitive schema and frameworks

(Fiol, 1994), institutional realm (Giddens, 1984), and shared knowledge of boundary objects that facilitate cross-functional coordination (Carlile, 2002); and (c) *inter-relational knowledge*, which is the organization members' multilateral understanding of each other's knowledge or task domain (Grant, 1996), such as transactive memory (Wegner, 1987) and coordination routines (Nelson et al., 1982). From this typology, common knowledge and inter-relational knowledge are embedded in interrelated activities among many people, not in individual minds (Weick et al., 1993), and therefore are considered *group-level knowledge*, which is the higher-order knowledge dealing with how to coordinate, share, distribute, and recombine individual-level knowledge (Cook et al., 1999). By this definition of group-level knowledge, it is clear that without the foundation of individual-level knowledge, group-level knowledge does not have a viable context. Therefore, a recipient community with a greater gain in its stock of individual-level knowledge will be more likely to have a larger increase in its stock of group-level knowledge.

Hypothesis 1: The more knowledge that individual members of the recipient community gain, the greater the transfer of group-level knowledge.

According to the knowledge-based view, an organization exists because it provides an environment conducive to the recombination of specialized knowledge (Kogut et al., 1992). A firm's capabilities not only reside in an array of individual specialties, but, more important, are stored in a wealth of group-level knowledge that generates value by integrating the individual specialties. In order to understand the group-level knowledge, it is critical to draw conceptual distinctions between individual-level and group-level phenomena in an organization. Group-level constructs, unlike their individual-level counterparts, highlight interdependent, systemic, and architectural aspects of activities or context; and hence are beyond the simple sum of individual constructs.

In the last three centuries, the dominant epistemology of Western culture, influenced by the Cartesian tradition, has developed a predilection for privileging the individual over the group (Cook & Brown, 1999; Weick & Roberts, 1993). As a result, the knowledge transfer paradigm underlying many prior studies does not distinguish group-level constructs from their individual-level counterparts. Emphasis has largely been given to the individual-level constructs. This theoretical blind spot has impaired our understanding of organization knowledge and its transfer. In the past decade, a few works have broken new ground in applying a multilevel perspective to the understanding of knowledge (Cook et al., 1999; Kogut et al., 1992; Levitt & March, 1988; Nonaka & Takeuchi, 1995) and learning (Argote, 1999; Crossan, Lane, & White, 1999; Grant, 1996). This study advances this breakthrough by conceptualizing and testing the group-level constructs of key building blocks of knowledge transfer framework, such as teaching strategies and absorptive capacities and working toward a more holistic multilevel knowledge transfer paradigm (see Figure 1 for a comparison between the traditional and multilevel knowledge transfer paradigms).

***** Figure 1 here *****

Group- vs. Individual-level Teaching

Knowledge transfer involves both replication and adaptation (Williams, 2003). Replication implies the teaching effort of a source entity, which imparts knowledge to the recipient entity by providing learning conditions and imposing rules, values, structure, artifacts, and mode of interaction to the recipient entity (Prochno, 2003). The major goal of replication is to identify and transfer the generic/transferable and useful knowledge within the knowledge base of the source community to the recipient community. The transferable and useful knowledge of

the source community is called the *Arrow Core* by Winter and Szulanski (2001). The Arrow Core of a firm's capabilities usually contains both individual-level knowledge and group-level knowledge, which is embedded in the source community's "field of interaction" (Nonaka & Takeuchi, 1995).

Contrary to the common perception that the individual is the primary undertaker of teaching actions, teaching actually happens at multiple levels, just as knowledge resides at different levels. Prior empirical studies (Zhao, Anand, & Mitchell, 2004) have revealed the coexistence of *individual-level teaching*, which occurs when a source community provides the recipient community members with access to the individual expertise of source community members through in-class training programs and apprenticeships, and *group-level teaching*, which happens when the source community grants recipient community members sufficient access to and immersion in the source community's field of interaction. Group-level teaching is done either through on-site training in the source community or sending to the recipient community an expatriate team, the size of which is large enough to carry most of the group-level knowledge of the source community to the recipient community. Practical manifestations of group-level teaching include overseas on-the-job training and joint engineering projects (Florida & Kenney, 2000; Inkpen & Dinur, 1998; Prochno, 2003).

Since individual-level knowledge is carried in the minds of individual teachers, an increased effort in individual-level teaching should lead to a greater flow of individual-level Arrow Core knowledge (e.g., individual skills in using certain engineering software or operating certain equipment) from the source community to the recipient community, and hence a greater gain in individual-level knowledge by the recipients.

Hypothesis 2.1: The more extensively the source community uses individual-level teaching, the greater the transfer of individual-level knowledge.

However, individual-level teaching cannot convey to the recipient community members the group-level knowledge embedded in the source community, no matter how intensively individual-level teaching is used, because the group-level knowledge of the source community can only be brought to play and revealed to the recipients when the members of the source community interact with each other to carry out inter-relational or inter-functional tasks. As Teece (1986: 2) noted, “While a single individual may sometimes hold the key to much organizational knowledge, group support is often needed, since organizational routines may need to be transferred.” Therefore, I suggest:

Hypothesis 2.2: The source community’s use of individual-level teaching has insignificant effect on the transfer of group-level knowledge.

Group-level teaching, on the other hand, provides several advantages over individual-level teaching. First, group-level teaching enables the recipient members to observe and understand the common and inter-relational knowledge, which are largely tacit and group-embedded. Second, group-level teaching helps recipient community members to internalize and buy into new values, priorities, and perspectives attached to the roles they would perform in the recipient community, which will motivate them to overcome their old ways of thinking. Third, group-level teaching also helps the recipient community members to de-contextualize the generic principles from the haze of idiosyncratic group-level knowledge embedded in the source community. Group-level teaching, therefore, surpasses individual-level teaching in transferring the source community’s knowledge, be it at individual or group level, to the minds of individual members of the recipient community.

Hypothesis 2.3a: The more extensively the source community uses group-level teaching, the greater the transfer of individual-level knowledge.

Hypothesis 2.3b: The source community's use of group-level teaching has more impact on the transfer of individual-level knowledge than the use of individual-level teaching.

The primary recipients of both individual- and group-level teaching efforts are individual members of the recipient community. Without integration and adaptation of individual-level learning based on local context, merely receiving the individual- and group-level knowledge by the individual members of the recipient community is unlikely to develop group-level knowledge within the recipient community (Prochno, 2003; Williams, 2003).

Hypothesis 2.4: The source community's use of group-level teaching has insignificant direct impact on the transfer of group-level knowledge.

Group- vs. Individual-level Learning

To transfer capabilities, replicating the source community's Arrow Core is not enough. A significant amount of new capabilities of the recipient community must be locally recreated and developed around the Arrow Core and framed within the local context (Prochno, 2003). Contrary to the traditional understanding that the individual is the primary locus of learning, learning actually happens at multiple levels; and most learning will happen at the intersections between roles, i.e., at group level (Crossan et al., 1999; Edmondson, Bohmer, & Pisano, 2001).

Individual-level learning is the learning action taken by and contained within individual members of the recipient community. Obviously, the more individuals put in efforts to learn, the more they will acquire individual-level knowledge.

Hypothesis 3.1: The more extensively the recipient community uses individual-level learning, the greater the transfer of individual-level knowledge.

However, individual-level learning alone will not develop the common knowledge and inter-relational knowledge, which comprise the group-level knowledge of the recipient community. In other words, individuals of the recipient community can acquire understanding of both individual-level knowledge and group-level knowledge of the source community through individual-level teaching and group-level teaching, but without the group integration process, they will not replicate and regenerate group-level knowledge within their own context.

Therefore, I suggest:

Hypothesis 3.2: The recipient community's use of individual-level learning has insignificant direct impact on transferring group-level knowledge.

Group-level learning describes the activities through which members of the recipient community interactively acquire, share, and combine knowledge into a collective product through shared experiences (Argote, 1999). Clearly, it is the inter-relational actions that distinguish group-level learning from individual-level learning. Practical examples of group-level learning include group brainstorming and meetings involving constant exchanges of new information, prioritization, and resource allocation. Compared to individual-level learning, group-level learning facilitates a deeper understanding of individual roles through the cross-fertilization of perceptions and perspectives among group members during social interactions (Nonaka & Takeuchi, 1995). Members of the recipient community can better understand one's own job area by seeing the big picture of how the entire team works together.

Hypothesis 3.3a: The more extensively the recipient community uses group-level learning, the greater the transfer of individual-level knowledge.

Hypothesis 3.3b: The recipient community’s use of group-level learning has more impact on the transfer of individual-level knowledge than the use of individual-level learning.

More important, learning at the group level enables members of the recipient community to integrate and institutionalize their understanding of the source community’s Arrow Core, build up a new field of interactions within the recipient community, and recreate their own set of group-level knowledge, such as shared understanding, routines, and transactive memory around the “Arrow Core” framed within the recipient community’s local context (Crossan, Lane, & White, 1999; Orlikowski, 2002; Prochno, 2003; Weick & Roberts, 1993).

Hypothesis 3.4: The more extensively the recipient community uses group-level learning, the greater the transfer of group-level knowledge.

Group- vs. Individual-level Absorptive Capacity

Absorptive capacity is the ability and condition of a firm to recognize valuable outside information, assimilate it and apply it for commercial ends (Cohen & Levinthal, 1990). Despite the importance of this construct in the knowledge transfer paradigm, it suffers a lack of theoretical elaboration and a well-established measuring system. Prior studies have used both individual-based measures, such as total number of or percentage of technical experts (Luo, 1997), and group-based measures, such as structural complementarities (Lane & Lubatkin, 1998), to measure absorptive capacity. However, my fieldwork and other empirical studies have indicated that the aggregation of individual-level knowledge in the recipient community does not account for a group-level learning outcome as significantly as the recipient community’s

structural conditions. This strongly implies a need to distinguish the absorptive capacities that exist at different organizational levels.

Individual-level absorptive capacity is the simple aggregation of the attributes of the individual recipients, such as their prior education, training, and work experience. Many measures used in the previous studies, such as number of extant patents, number of in-house experts, number of R&D personnel, percentage of employees who have information on state-of-the-art technical knowledge, are individual-based and should be categorized as individual-level absorptive capacity. Since memory is enhanced through associative learning, a prior knowledge base enables individuals to acquire new knowledge (Cohen & Levinthal, 1990).

Hypothesis 4.1: The greater the individual-level absorptive capacity of the recipient community, the greater the transfer of individual-level knowledge.

However, my exploratory fieldwork and other empirical studies have demonstrated the inability of the individual-level knowledge base to receive new group-level routines and practices (Tsang, 2003; Zhao et al., 2004). Without appropriate structural conditions, an assembly of knowledgeable individuals may get stuck in the competence trap (Leonard-Barton, 1992). My case studies show that a high proportion of well-educated and experienced experts within an organization does not necessarily provide a condition conducive to acquiring group-level knowledge.

Hypothesis 4.2: The extent of individual-level absorptive capacity of the recipient community has insignificant direct impact on the transfer of group-level knowledge.

Group absorptive capacity, on the other hand, relates to structural and cultural attributes of the recipient community that characterize the recipient community's sensitivity to external knowledge and adaptability to change. In the structural aspect, Grant (1996) argued that

organizational structures can be designed to maximize the efficiency of knowledge integration. Research also has shown that Greenfield recipient organizations, free from the restraints of the obsolete structure, are more likely to absorb knowledge from a source community (Gupta & Govindarajan, 2000). Furthermore, other structural attributes such as possession of a common style of communicating (Matusik & Heeley, 2001), a similarity in structure to the source community (Lane & Lubatkin, 1998), organizational a structure with few hierarchical barriers (Goh, 2002), a team-based compensation system (Draaisma, 2001; Goh, 2002), certain patterns of group composition (Burderson & Sutcliffe, 2002; Ellis, Hollenbeck, Ilgen, & Porter, 2002), and implementing CAD/CAM systems (Badham, Couchman, & Zanko, 2000) are shown to have positive effects on knowledge acquisition by the recipients.

Similarly, the cultural aspect of group-level absorptive capacity also is critical for absorbing and adopting new knowledge within the recipient community. Research has shown that a shared vision of the organizational goal, a continuous improvement culture, a culture of cooperation and collaboration, a high level of trust among members, and a risk-taking orientation (Badham, Couchman, & Zanko, 2000; Draaisma, 2001; Goh, 2002; Huber, 1991) are all contributive to the knowledge gained within the recipient community. Unlike individual-level absorptive capacity, group-level absorptive capacity is conducive to acquiring both individual- and group-level knowledge, because it provides the structural and cultural environment for recipients to learn both as individuals and as a community. A strong group-level absorptive capacity provides learning orientation and conditions to each individual member of the recipient community, and therefore allows them to acquire and develop their individual-level knowledge more effectively.

Hypothesis 4.3a: The greater the group-level absorptive capacity of the recipient community, the greater the transfer of group-level knowledge.

Hypothesis 4.3b: Group-level absorptive capacity of the recipient community has more impact than individual-level absorptive capacity on the transfer of individual-level knowledge.

Poor group-level absorptive capacity implies core rigidity, insensitive or even resistant to change in collective mentality (e.g., market-orientation in product design) and group-wide routines. My case studies show recipient communities that maintain obsolete organizational structure of state-owned firms are much more difficult to develop advanced capabilities even though their members have relatively high individual-level absorptive capacity. Therefore, I suggest:

Hypothesis 4.4: The greater the group-level absorptive capacity of the recipient community, the greater the transfer of individual-level knowledge.

Toward a Multi-level Knowledge Transfer Paradigm

The above discussion has revealed the need for expanding the traditional unitary-level knowledge transfer paradigm to a multilevel one to better understand the causal mechanisms of the transfer of different levels of knowledge. Three key building blocks of the knowledge transfer paradigm, namely teaching strategies, learning strategies, and absorptive capacity, are studied with a multilevel perspective. Both group- and individual-level of these concepts are defined, and their effects on the transfer of different levels of knowledge are hypothesized. There is an apparent asymmetry between the group- and individual-level explanatory constructs. All

group-level constructs are hypothesized to contribute to the transfer of knowledge more effectively than their individual-level counterparts. The overall theoretical framework is shown in Figure 2.

***** Figure 2 here *****

Research Methodology

Empirical Setting

I selected the activities of transferring engineering capabilities in the Chinese auto industry as the empirical setting for this study for several reasons. First, engineering capabilities in the automotive industry, especially R&D project management, involve substantial group-level knowledge, especially the generic type of group-level knowledge, or Arrow Core at group level. For instance, the principles of concurrent engineering, robust design, quality planning, and document control are all at group level and can be applied to different cultural or industrial contexts. Second, China is the world's fastest-growing auto market, and there is growing incidence of transferring R&D practices from MNEs to Chinese-based auto facilities. MNEs began forming joint ventures with local firms during the early 1980s, beginning with Volkswagen and followed by Chrysler, Delphi, GM, Ford, Toyota, PSA, and others. Chinese technology policy has required R&D capability transfer in the joint ventures. The MNEs have competitive incentives to develop technical capabilities at their local affiliates in order to counter post-WTO competition in the globalized local market. The practical importance of this transfer practice is significant.

Third, there are substantial cultural, technical, and managerial differences between recipient organizations in China and MNE source units (Beamish, 1993; Child & Yan, 2001).

This large asymmetry between the source and recipient communities provides sufficient cross-case variations in choices of knowledge transfer mechanisms and knowledge transfer outcomes. Fourth, since the original stock of capabilities in these firms are either insufficient or obsolete before the formation of joint ventures, the outcomes of the capability acquisition efforts are mostly due to these efforts themselves, not other noise factors. Finally, the use of a single industry helps control for industry-level factors. Despite the single-industry setting, I expect generalizability of the conclusions to go beyond this industry setting because the concepts, the framework, and the questionnaire are developed from extensive literature review and are not industry-specific.

Methods

This study involves both exploratory and confirmatory approaches. The explanatory approach provides rich and accurate details, while the confirmatory study imposes rigor, structure, and generality to the findings. In the exploratory phase, I conducted 31 open-ended interviews, 26 in-depth, semi-structured interviews, and field observations in nine international joint ventures in the Chinese auto industry. The primary purpose of this phase is to understand the context, process, and contributing factors for the inter-partner transfer of R&D capabilities. It was through the qualitative analysis of these field data (Strauss & Corbin, 1990) that the definitions of key constructs and the multilevel knowledge transfer paradigm emerged. The confirmatory phase of this work is a mail survey, which provides better face and content validity for latent concepts in the knowledge-based research than methods relying on objective data (Henderson & Cockburn, 1994). In the following, I will focus on the discussion of survey methods and findings.

Sample and Data Collection

The sampling frame of this study is the directory of Chinese automotive firms listed in the *Chinese Automotive Industry Yearbook* (2003). From this frame, I selected 398 firms that have indication of having foreign parents or partners and have annual revenue above 2.5 million RMB (or about 0.3 million USD).

The questionnaires were sent to the managers in engineering units, such as R&D departments, technical centers, or manufacturing departments. I acquired the names of the informants by calling each selected firm, secondary data sources (industry reports and newspaper), and word of mouth from acquaintances. I sent at least two survey questionnaires to each engineering unit in order to collect as many repeated responses as possible.

The final sample consisted of 201 responses from 137 unique firms. The firm-level return rate is 34.8%, which is very good considering other survey studies done in China, for instance, 14.4% in the study of Isobe and colleagues (2000). These 201 responses involve 161 separate engineering units, and 25 of them have multiple responses. I use “total employment of the firm” as a measure of firm size and calculate non-response bias. The two-tailed t-test on the means of the respondent and non-respondent group is not significant ($p=.542$). I also followed (Ghoshal & Bartlett, 1988; Gupta et al., 2000; Li & Atuahene-Gima, 2002) to conduct a check on inter-rater agreement based on a sub-sample of 25 units that provided multiple responses. I found significant inter-rater correlation on the key constructs such as group-level knowledge transferred (inter-rater correlation = .477, $p=.025$), individual-level learning (inter-rater correlation = .522, $p=.007$), and individual-level absorptive capacity (inter-rater correlation = .582, $p=.002$). In addition, I checked for common method bias using Harman’s one-factor test. A principal factor analysis of all measurement items yielded 10 factors with Eigen values larger

than one. These factors accounted for 72.9% of the variance. Since no single factor emerged as a dominant factor accounting for most of the variance, common method variance is unlikely to be a serious problem in the data (Podsakoff & Organ, 1986).

The questionnaire. The survey questionnaire has gone through four iterations of drafting, translations, back-translations, pre-tests, and revisions. This extensive refinement process helps to improve the grouping and flow of the questions, adjust the expression of some questions to make them more relevant to the respondents, and eliminate some questions that are redundant, lacking variation, vague, or difficult to answer. The final questionnaire is written in Chinese and is eight pages long, with 15 categories and 144 questions. It requires 20 to 30 minutes to complete.

Measures

The items reflecting all constructs used in the study are described in Appendix A. Since there is little extant scale for any of the constructs, I depend on extensive exploratory fieldwork, thorough literature review, and many rounds of pretests and revisions to design multiple items that adequately cover the content domain of each construct and are relevant to the empirical context. I use a 7-point Likert scale for most of the questions so the data can be treated as interval data in subsequent analyses.

Independent variables. Four constructs relating to the teaching and learning strategies, namely group-level teaching (GT), individual-level teaching (IT), group-level learning (GL), and individual-level learning (IL), are the key building blocks of the theoretical framework. To measure the extent to which firms implement a certain teaching or learning strategy, I focus on the degree of “regularity or routineness” of practices firms used reflecting this strategy. This type

of question, designed as a 7-point Likert scale, with 1= “Never” and 7= “Very routinely” or “to a great extent,” are easy and meaningful for respondents to assess (Kale, 1999).

Dependent variables. The two dependent variables, group-level knowledge transferred (GK) and individual-level knowledge transferred (IK), are similar to ‘learning outcome,’ which has been used by many researchers with different emphases. I focus on the improvement in knowledge stock and resulting actions (Simonin, 1991). When designing questions to measure performance, it is conventional to restrict the recall time frame to three years (Miller, Cardinal, & Glick, 1997). I use 7-point Likert scale with 1 = “to a minimal extent,” 4 = “to some extent,” and 7 = “to a great extent.”

Control variables. There are two main control variables: teaching motivation (TMOT) and learning motivation (LMOT). Teaching motivation is the extent to which the source organization is motivated to transfer their knowledge to the recipient organization. This implies that the source organization sees benefit in helping the recipient organization to develop capabilities (Szulanski, 1996), the source organization is open for the recipient organization to learn (Hamel, 1991), and the source organization is committed to teach the recipient organization (Lyles & Salk, 1996).

Learning motivation is the extent to which the recipient organization is motivated to acquire new knowledge and develop capabilities from external sources. The level of learning motivation is reflected by whether the recipient organization has a clear learning agenda (Simonin, 1991), has a sense of urgency in learning (Hult, Ketchen, & Nichols, 2002), and regards learning from the source organization as an important objective (Hamel, 1991).

Analysis and Results

The main analytical approach for hypothesis testing is structural equation modeling (SEM). I follow Anderson and Gerbing's (1988) two-stage procedure to evaluate the measurement model before testing the structural model.

Measurement Model

I conducted a comprehensive check of reliability, convergent and divergent validity of all constructs in the measurement model. A few indicators are dropped due to poor normality or low loading. The measurement model with the retained indicators fits the data well (Chi-square = 1195.4, $df=724$, $p<.001$, NFI=.94, RFI=.93, CFI=.097, RMSEA=.05), indicating there was no fundamental misspecification in the measurement model. The standardized loadings, as shown in Table 1, are highly significant with p value lower than .001 and highly related to their respective constructs with standardized loading ranging from .46 to .87, thus providing further evidence of convergent validity. The Cronbach's alphas of all constructs, shown in Table 1, range from .76 to .89, satisfying Nuanlly's (1978) minimum criterion for internal consistency (.70).

***** Table 1 here *****

The discriminant validity of each construct was checked using two criteria: (1) the 95% confidence interval of inter-construct correlation should not include 1, and (2) the average shared variance coefficient of each construct should be greater than squared correlation between this construct and any other construct in the model (Fornell & Larcker, 1981). The results of these two tests show that the discriminant validity of all constructs is evidenced. Table 2 presents means, standard deviations, and correlations for the constructs.

***** Table 2 here *****

Structural Model

To ensure a solid specification of the structural model, I use hierarchical regression to test the effects of interaction terms of independent variables and secondary control variables (such as firm size, source nationality, R&D intensity, competition intensity, and marketing capability) on the two dependent variables, GK and IK. The regression results show neither significant interaction effect nor significant effects of any secondary control variables. Based on this result, I leave the interaction effects and secondary control variables out of the main structural model (Model 1), which is the same as the model shown in Figure 2.

Model 1 has an adequate fit to the data (Chi-square = 1063.18, df=610, p<.001, NFI = .94, RFI=.93,, TLI=.97, CFI=.97, RMSEA=.068). To address the concern for small sample size (161) relative to the number of free estimates (130) in this model, I tested the same structural model with composite indices as suggested by (Liang, Lawrence, Bennett, & Whitelaw, 1990). The model with composite indices (Model 1a) drastically reduced the number of free estimates from 130 to 39, and still achieved a reasonable fit (Chi-square = 77.44, df=26, p<.001, NFI=.98, RFI=.97, TLI=.98, CFI=.99, RMSEA=.11). More important, the value and significance of all estimates are very similar between Model 1 and Model 1a, indicating that the sample size of this study does not cause unreliable estimation problem. Table 3 reports the parameter estimates for Model 1 and Model 1a.

***** Table 3 here *****

The standardized parameter estimate (for simplicity, referred to as parameter estimate hereafter) of the path between IK and GK is positive and significant ($\beta_{78} = .357$, p<.001), supporting Hypothesis 1, which states that the more knowledge individual members of the recipient community gain, the greater the transfer of group-level knowledge. The significantly

positive relationship between IT and IK ($\beta_{17} = .174, p < .05$) lends support to Hypothesis 2.1, which states that the more extensively the source community uses individual-level teaching, the greater the transfer of individual-level knowledge from the source community to the recipient community. The construct GT shows a significantly positive effect on IK ($\beta_{27} = .457, p < .001$) in support of Hypothesis 2.3a, which states that the more extensively the source community uses group-level teaching, the greater the transfer of individual-level knowledge from the source community to the recipient community. The parameter estimate of the path between IL and IK is positive but insignificant ($\beta_{37} = .053, p > .1$), thus does not support Hypothesis 3.1, which states that the more extensively the recipient community uses individual-level learning, the greater the transfer of individual-level knowledge. Similarly, the parameter estimate of the path between GL and IK is positive but insignificant ($\beta_{47} = .141, p > .1$) and thus does not support Hypothesis 3.3a, which states that the more extensively the recipient community uses group-level learning, the greater the transfer of individual-level knowledge.

Hypothesis 3.4, stating that the more extensively the recipient community uses group-level learning, the greater the transfer of group-level knowledge, is supported by the significantly positive relationship between GL and GK ($\beta_{48} = .333, p < .001$). The parameter estimate of the path between IAC and IK is positive but insignificant ($\beta_{57} = .084, p > .1$) and thus does not support Hypothesis 4.1, which states that the greater the individual-level absorptive capacity of the recipient community, the greater the transfer of individual-level knowledge. Hypothesis 4.3a, stating that the greater the group-level absorptive capacity of the recipient community, the greater the transfer of individual-level knowledge, is supported by the significantly positive relationship between GAC and IK ($\beta_{67} = .333, p < .05$). Further, Hypothesis 4.4, stating that the greater the group-level absorptive capacity of the recipient community, the greater the transfer of

group-level knowledge, is supported by the significantly positive relationship between GAC and GK ($\beta_{68} = .313, p < .001$).

I evaluated the three comparative hypotheses (Hypothesis 2.3b, 3.3b, and 4.3b) by comparing the path estimates of interest using two-sample t-tests. All these hypotheses, indicating the superiority of the group-level mechanisms over their individual-level counterparts, are strongly supported at .001 level.

Four hypotheses that propose insignificant relationships (Hypotheses 2.2, 2.4, 3.2, and 4.2) were tested using four next-best unconstrained models (Model 2, 3, 4, and 5), which added the proposed insignificant paths back to Model 1. The Chi-square difference tests between Model 1 and these models showed that Model 1 was preferred above all other models. Moreover, the parameter estimates of the added paths were all insignificant. Thus, Hypotheses 2.2, 2.4, 3.2 and 4.2 are supported. Table 4 presents model statistics and Chi-square difference tests of alternative models against Model 1.

***** Table 4 here *****

The two control variables included in the model, TMOT and LMOT, show significantly positive relationships to various levels of teaching and learning strategies as predicted, indicating that the two levels of teaching and learning are strongly affected by teaching and learning motivations respectively. Therefore, including these two motivational factors in the model as antecedents to teaching and learning strategies avoids the self-selection bias that is common in strategy-performance models (Shaver, 1998).

The overall explanatory power of the full structural model is assessed by looking at the squared multiple correlation (SEC) of the two dependent variables. This parameter is similar to

the R^2 value of the regression model. The SEC is .540 for IK and .631 for GK, indicating sufficient explanatory power of the full structural model.

Discussion and Implications

Several important implications are derived from this study. First, the causal mechanism for transferring group-level knowledge is different from that for transferring individual-level knowledge. The results suggest that group-level learning and group-level absorptive capacity are significant contributors to the transfer of group-level knowledge, whereas individual-level teaching, group-level teaching, and group-level absorptive capacities are significant contributors to the transfer of individual-level knowledge. Organization capability involves both individual- and group-level knowledge (Cook et al., 1999; Spender, 1996). However, group-level knowledge is usually more valuable, dominant, and difficult to transfer than individual-level knowledge. Through separating individual- and group-level knowledge in the theoretical model, the study of capability transfer gains sharper resolution and thus is able to shed light on the solutions to the empirical puzzle that inspired this study: How capabilities can be transferred effectively.

Second, teaching occurs at different organizational levels, and different levels of teaching impact the transfer of individual-level knowledge differently. The confirmatory factor analysis indicates that the concepts of group- and individual-level teaching are distinct from each other. The result of the structural equation model suggests that group-level teaching has stronger impact on transferring the individual-level knowledge compared to individual-level teaching. My exploratory interviews provide rationale for this finding. Group-level teaching is advantageous over individual-level teaching in that it provides recipients opportunities to understand the culture, norm, and routines of the source community and tease out the generic and useful

knowledge from the source's knowledge set. This finding counters the conventional wisdom, which views teaching largely as individual-level actions and relies on individual level to transfer capabilities, even when the capabilities have a large portion of group-level knowledge. Firms in my exploratory studies, for instance, often rely on the measure of person-hour of teaching provided by the source as an indicator of the total amount of teaching they have received. This measure, apparently, is of individual-level teaching.

The third implication of this study confirms the prior research that learning takes place at different organizational levels (Argote, 1999), and different levels of learning have different effect on the transfer of knowledge (Crossan et al., 1999). The SEM results show that individual-level learning does not have significant impact on transferring group-level knowledge, while group-level learning does. This finding highlights the importance of group-level learning in the process of capability transfer. In the practical realm, however, firms that I have interviewed in the exploratory phase of this study show little awareness of the importance of group-level learning. Many training managers rely on the measure of person-hours in training as the key measure of learning. This measure, however, is of individual-level learning.

The fourth implication of this study suggests that absorptive capacity resides at different organizational levels, and different levels of absorptive capacity have different impact on transferring either group- or individual-level knowledge. Although absorptive capacity has been studied extensively (Cohen et al., 1990; Gupta et al., 2000; Lane et al., 1998; Mowery, Oxley, & Silverman, 1996), little is known about the nature and effects of absorptive capacity at the group level. In this study, I have shown that group-level absorptive capacity is more effective than individual-level absorptive capacity in transferring both individual- and group-level knowledge. This finding provides an interesting twist to the common staffing practices in the field. Firms

usually tempt to staff members with high levels of education and experience, which builds up individual-level absorptive capacity. However, this study indicates that when transferring knowledge is the main objective, group-level absorptive capacity, such as the structural flexibility, learning orientation, and communication openness of the organization, are much more important than individual-level attributes, such as education and prior experience.

This study also yields some non-significant findings. First, different from what I have hypothesized, individual- and group-level learning show no significant effect on the transfer of individual-level knowledge in the overall structural model. However, in an additional test with SEM without teaching related variables, such as teaching motivation, group-level teaching, and individual-level teaching, the effect of individual-level learning becomes marginally significant with path estimate of .136 and p value of .100, and the effect of group-level learning becomes significant with path estimate of .331 and p value of .018. This finding implies that the non-significant effects of group- and individual-level learning on the transfer of individual-level knowledge should be taken with caution, because the effects of group- and individual-level learning may be overshadowed by the stronger effects of the teaching-related variables.

The results of this study surprisingly do not find significant effect of individual-level absorptive capacity on transferring individual-level knowledge, contrary to the received wisdom that a prior knowledge or experience base helps individuals acquire new related knowledge. One possible explanation is that in the China context, the prior knowledge and experience are obsolete and not closely related to the new skills individuals attempt to acquire. Therefore, this finding may not be generalizable to other settings where prior knowledge and experience may be related to the knowledge to be acquired.

Theoretical Contributions

This study contributes to the resource-based view or knowledge-based view in particular in several ways. Fundamentally, tangential to the direction of prior knowledge transfer research, which largely attempts to expand the scope of the knowledge transfer paradigm by including more explanatory factors, this research focuses on the individual-group distinction of existing explanatory factors.

Prior knowledge-based research attributes the stickiness of knowledge to motivational factors (Porter, 1985), lack of absorptive capacity (Szulanski, 1996), and tacitness of knowledge (Polanyi, 1962). This study, however, focuses on another source of knowledge stickiness – group-level knowledge (Winter, 1987; Kogut & Zander, 1992; Nonaka & Takeuchi, 1995; Grant, 1996). Group-level knowledge is valuable because it coordinates the distribution and integration of individual-level knowledge and thus generates value for the firm. Although some portion of group-level knowledge can be codified, the majority of group-level knowledge is tacitly embodied in the norms, collective cognitive schema, and routines, which are hard to be observed by outsiders because they can only be brought to play when group members interact with each other. Therefore, separating group-level knowledge from individual-level knowledge in the knowledge transfer framework helps to gain insights of the causal mechanisms for transferring group-level knowledge.

This study, through extensive fieldwork and confirmatory work, has developed and validated group- and individual-level aspects of core knowledge transfer concepts such as teaching and absorptive capacity. These conceptual establishments build on to the existing conceptualization of group- and individual-level learning and work toward an integral multilevel knowledge-transfer paradigm.

The findings of this study imply a strong asymmetry between group-level and individual-level knowledge transfer mechanisms. In general, group-level teaching, learning, and absorptive capacity are more effective than their individual-level counterparts in transferring different levels of knowledge. This finding points out an apparent misalignment of prior strategic focus in knowledge transfer, with bias toward individual-level mechanisms. This misalignment of strategic focus, leading to over-investment in individual-level teaching, learning, and absorptive capacity, may contribute to the high failure rate of capability transfer (Collis et al., 1995; Ruggles, 1998).

Empirical Implications

First and foremost, managers must realize that capabilities do not only reside in documents, drawings, and the aggregation of individual skills. A large portion of capabilities lies in group-level knowledge, such as organizational culture, shared engineering language, norm of communication and problem solving, cross-functional routines, and inter-personal knowledge of “who does what.” Group-level knowledge is more valuable and sustainable than individual-level knowledge. However, it is also more difficult to transfer and receives less attention. The more important and challenging task in leveraging capabilities is transferring the group-level knowledge, not just individual roles.

To transfer group-level knowledge from one community to another does not mean exact replication, because the group-level knowledge of the source community has some portion of local-specific content, which is may be neither feasible nor beneficial to transfer to the recipient community. Therefore, replication, by identifying and copying the generic and useful knowledge of the source community, should only be treated as a stepping stone for adaptation, which completes the task of capability transfer by generating a new set of capabilities around the generic knowledge learned from the source based on the recipient’s local context.

At the replication stage, it is important to create opportunities for as many members of the recipient community to submerge in the “field of interaction” at the source community as

possible. Using in-class training, one-on-one teaching, or sending expatriates in a scattered manner is helpful but not enough. In addition to technical skills, recipients may need to pay close attention to the source community's culture, norm, and ways of interaction among people and functional areas. It is also important for recipients to contemplate on which part of the source community's knowledge can or cannot be applied back home. Meanwhile, the recipient community should make efforts to consciously create a bridge network with the source community through joint work or social activities.

At the adaptation stage, it is important for the members of the recipient community to work on community-wide real projects (not mock ones), and intentionally encourage, reflect upon, and routinize inter-personal or inter-functional best practices. Managers must create forums to allow employee to discuss, brainstorm, and resolve conflicts collectively, and through these activities develop a collaborative and learning-oriented culture. Without adaptation through intense intra-group interactions, the efforts invested in the replication stage may not generate meaningful return.

It is also important to know that having a group of highly educated and experienced personnel does not always mean the group can acquire new capabilities faster and better. In fact, individual-level attributes have much less to do with acquiring new capabilities than group-level characters such as team-oriented culture, group-wide learning-orientation, an open and effective communication system, and implementation of electronic-based data management and reporting system.

Last but not least, the above-mentioned group-level strategies and absorptive capacity must be initiated and implemented by managers in a top-down manner. Managers' active involvement in these areas is the key to the successful implementation of these group-level strategies and thus the success of capability transfer efforts.

Future Research

Diverting from the traditional knowledge transfer research, which works toward enlarging the scope of knowledge transfer paradigm, this study opens up a new research direction, which points to the individual-group distinction within the existing knowledge transfer mechanisms. Future research may advance this research direction by exploring the generality of my findings across different empirical settings. The effects of different levels of teaching, learning, and absorptive capacity on transferring different levels of knowledge may not be the same when the technological and managerial gaps between the source and recipient units are not as big as those presented in this study.

Additional studies are needed to examine the sequential and interaction effects between different levels of teaching and learning. Would applying individual-level teaching and learning before group-level teaching and learning be beneficial for transferring knowledge? Would extensive application of individual-level teaching and learning reduce the need for group-level teaching and learning, and vice versa? These fine-grained questions await future investigation.

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Table 1. Item and Construct Statistics of the Overall Measurement Model

Constructs	Cronbach's Alpha	Items (final selection)	Standardized Regression Weights
BN	0.846	bn04	0.692***
		bn06tr	0.870***
		bn07tr	0.697***
		bn08tr	0.838***
GAC	0.818	gac03	0.621***
		gac06	0.651***
		gac07	0.581***
		gac08	0.730***
		gac09	0.864***
IAC	0.840	iac03	0.455***
		iac04	0.584***
		iac06	0.885***
		iac07	0.807***
		iac08	0.722***
GL	0.763	gl01	0.785***
		gl02	0.871***
		gl03	0.486***
IL	0.821	il01	0.836***
		il02	0.834***
		il03	0.676***
GT	0.890	gt02	0.806***
		gt03	0.862***
		gt04	0.830***
		gt05	0.772***
IT	0.875	it01	0.883***
		it02	0.880***
GK	0.865	gk02	0.731***
		gk04	0.783***
		gk05	0.786***
		gk06	0.832***
IK	0.777	ik01	0.776***
		ik02	0.711***
		ik03	0.739***
LMOT	0.811	lmot02	0.799***
		lmot03	0.588***
		lmot04	0.771***
		lmot05	0.644***
		lmot06	0.669***
TMOT	0.839	tmot01	0.859***
		tmot02	0.978***
		tmot03	0.596***

Table 2 Descriptive Statistics of Main Constructs

Construct	N	Min	Max	Mean	Std. Deviation	Pearson Correlation (2-tailed <i>p</i> -value)									
						GT	IT	GL	IL	GK	IK	GAC	IAC	LMOT	
GT	141	1.000	7.000	3.764	1.558										
IT	141	1.000	7.000	4.058	1.508	0.409 ***									
GL	161	1.230	7.000	4.870	1.182	0.435 ***	0.396 ***								
IL	161	1.290	7.000	4.608	1.339	0.471 ***	0.362 ***	0.514 ***							
GK	161	2.500	7.000	5.173	0.915	0.405 ***	0.311 ***	0.592 ***	0.477 ***						
IK	161	1.650	7.000	4.873	0.965	0.610 ***	0.418 ***	0.470 ***	0.439 ***	0.584 ***					
GAC	161	1.740	7.000	5.148	1.030	0.256 **	0.225 **	0.475 ***	0.423 ***	0.515 ***	0.410 ***				
IAC	161	1.130	7.000	4.026	1.431	0.446 ***	0.220 **	0.388 ***	0.489 ***	0.310 ***	0.402 ***	0.305 ***			
LMOT	161	1.190	7.000	5.013	1.131	0.466 ***	0.298 ***	0.538 ***	0.579 ***	0.515 ***	0.402 ***	0.533 ***	0.511 ***		
TMOT	143	1.000	7.000	4.289	1.509	0.481 ***	0.558 ***	0.294 ***	0.226 **	0.330 ***	0.370 ***	0.240 **	0.254 **	0.277 **	

p<.05; **p<.01; *p<.001*

Table 3. Standardized Loadings of Model 1 and Model 1a and Hypothesis Tests

Paths		Models		Hypotheses	
		Model 1	Model 1a	Number	Support or Not
GK <-- IK	β_{78}	0.365***	0.357***	H1	Yes
IK <-- IT	β_{17}	0.147+	0.174*	H2.1	Yes
IK <-- GT	β_{27}	0.491***	0.457***	H2.3a	Yes
IK <-- IL	β_{37}	0.024	0.053	H3.1	No
IK <-- GL	β_{47}	0.153	0.141	H3.3a	No
GK <-- GL	β_{48}	0.377***	0.333***	H3.4	Yes
IK <-- IAC	β_{57}	0.089	0.084	H4.1	No
IK <-- GAC	β_{67}	0.228*	0.223*	H4.3a	Yes
GK <-- GAC	β_{68}	0.250**	0.313***	H4.4	Yes
IT <-- TMOT		0.670***	0.641***		
GT <-- TMOT		0.589***	0.521***		
IL <-- LMOT		0.764***	0.735***		
GL <-- LMOT		0.749***	0.709***		

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 4. Model Statistics and Chi-Square Difference Tests Against Model 1

Model	Description	χ^2	df	p	$\Delta\chi^2$	df	p for $\Delta\chi^2$	Preferred Model	Hypothesis	Supported or Not
1	Main theoretical model	1063.18	610	<.001						
2	Model 1 plus a path of IT on GK (Next-best unconstrained)	1062.25	609	<.001	.93	1	.336	Model 1	H2.2	Yes
3	Model 1 plus a path of GT on GK (Next-best unconstrained)	1062.22	609	<.001	.96	1	.327	Model 1	H2.4	Yes
4	Model 1 plus a path of IL on GK (Next-best unconstrained)	1062.93	609	<.001	.25	1	.619	Model 1	H3.2	Yes
5	Model 1 plus a path of IAC on GK (Next-best unconstrained)	1061.58	609	<.001	1.60	1	.206	Model 1	H3.4	Yes

Figure 1. Contrasting Paradigms of Knowledge Transfer

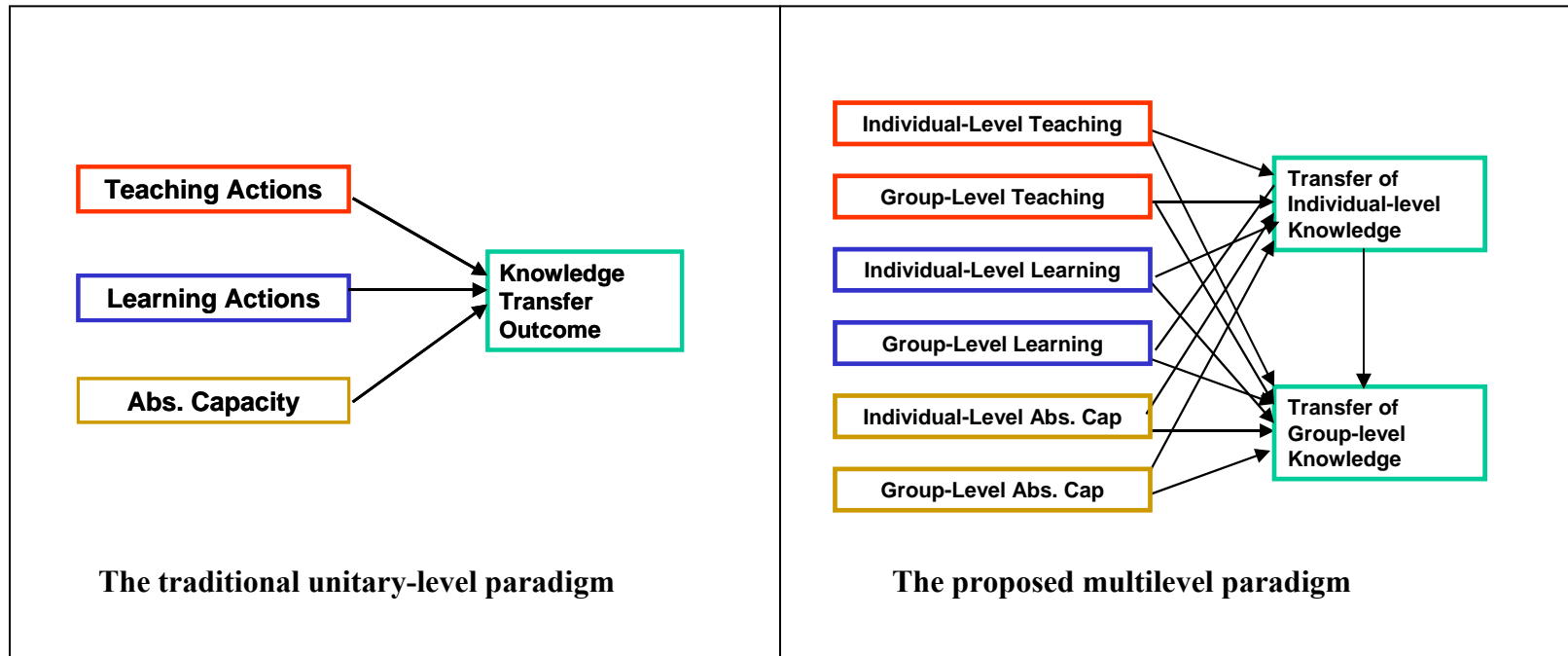
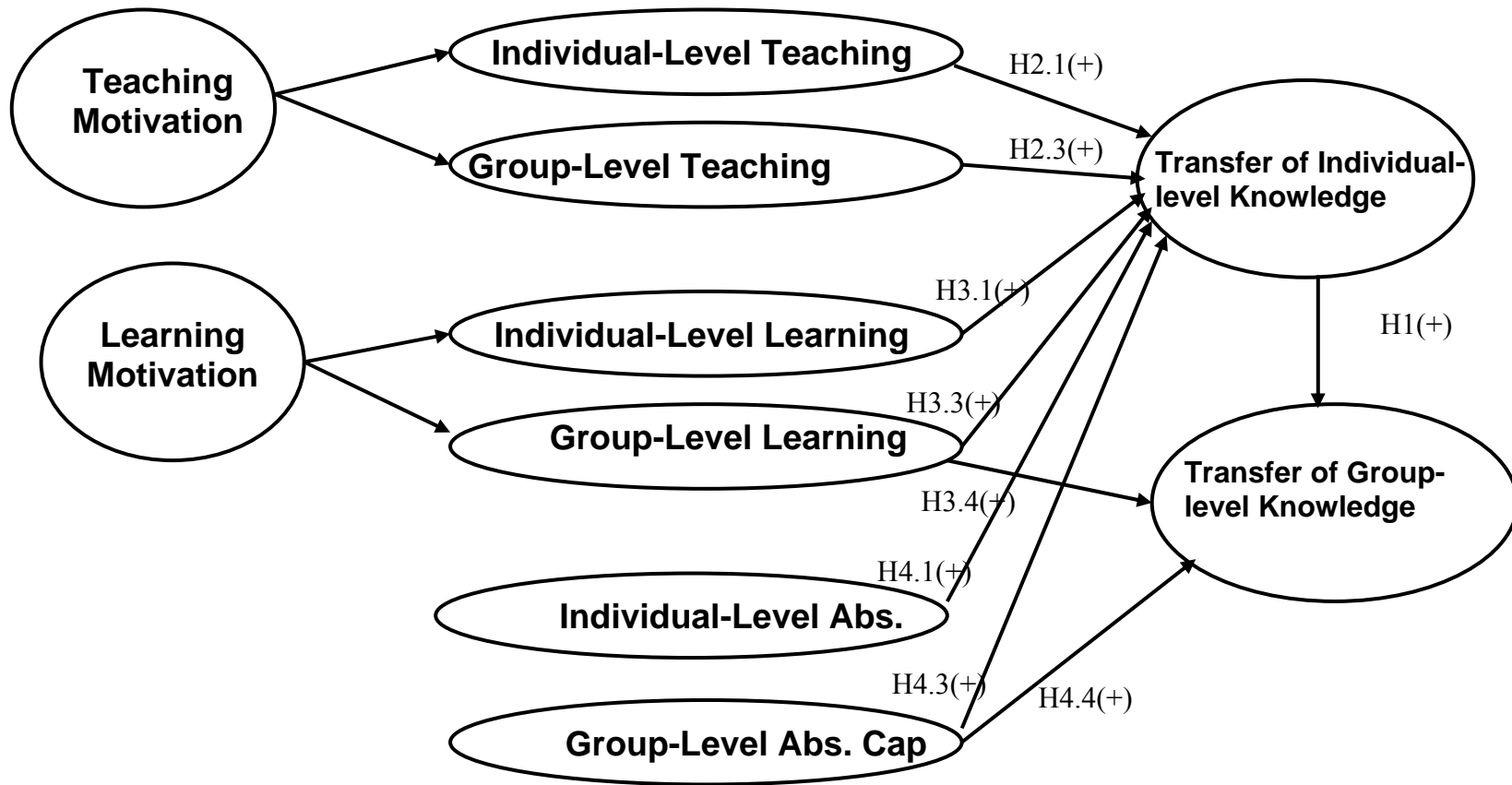


Figure 2. Diagram of Hypotheses



Appendix A.

Summary of Constructs and Question Items

Group Teaching (GT)

Reference: (Almeida & Grant, 1998; Inkpen & Dinur, 1998; Subramaniam & Venkatraman, 2001; Florida & Kenney, 2000; Minbaeva, et al, 2002)

- GT01. The Source Unit demonstrated to your employees how they communicate technical information with each other in routine work.
- GT02. The Source Unit demonstrated to your employees how to they resolve cross-function issues as a team
- GT03. The Source Unit demonstrated collectively to your employees how they jointly plan and carry out a technical project
- GT04. The Source Unit involved your employees in their cross-functional meetings
- GT05. The Source Unit carried out joint projects with your employees?
- GT06. Individuals from your unit were sent to the Source Unit's site for on-the-job training
- GT07. A team of members of your unit were sent to the Source Unit's site for on-the-job training
- GT08. The Source Unit sent a team of expatriates with different specialties to work at your department

Individual Teaching (IT)

- IT01. The Source Unit arranged experts to teach technical skills to your employees
- IT02. The Source Unit provided individual on-site technical assistance to your employees for their daily work
- IT03. The Source Unit provided technical assistance through phone or email

Group Learning (GL)

References: (Minbaeva et al., 2002; Crossan et al., 1999; Lane, 1998; Lemieux-Charles, 2002)

- GL01. Conducting cross-function projects
- GL02. Paying special attention to spreading best practices in solving cross-function problems
- GL03. Having cross-function meetings to solve technical issues
- GL04. Making special efforts to adapt what you have learned from our FP to our local context
- GL05. Openly sharing new knowledge, information and opinions among each other

Individual Learning (IL)

- IL01. Acquiring technical knowledge from on-job training or internal training classes
- IL02. Acquiring technical or managerial knowledge from external training courses
- IL03. Visiting firms that have advanced technical capabilities
- IL04. Worked at a one-on-one basis with foreign experts
- IL05. Acquired technical knowledge from the foreign experts.
- IL06. Going to tradeshows, exhibitions, conferences and etc.

Individual Level Absorptive Capacity (IAC)

Reference: (Simonin, 1991; Lane and Lubatkin, 1998; Luo, 1997)

- IAC01. Percentage of group members who have engineering degrees from college

- IAC02. Percentage of group members who have more than 5 years of experience in their specialty
- IAC03. Percentage of group members who have sufficient foreign language skills
- IAC04. Percentage of group members who have gone through formal trainings in product or process design
- IAC05. Percentage of group members who have gone through formal trainings in quality control
- IAC06. Percentage of group members gone through team building programs
- IAC07. Percentage of group members who have gone through corporate culture development
- IAC08. Percentage of group members who have gone through project management training

Group Level Absorptive Capacity (GAC)

Reference: (Gupta & Govindarajan, 2000; Goh, 2002; Draaisma, 2001; Burnderson & Sutcliffe, 2002; Ellis, Hollenbeck, Ilgen, & Porter, 2002; Badham, Couchman, & Zanko, 2000)

- GAC01. We maintained a strong SOE-type structure (reverse coding)
- GAC02. We maintained a strong SOE-type group mentality (reverse coding)
- GAC03. Our performance evaluation system and incentive system encourages teamwork (team-based compensation)
- GAC04. We have an excellent information technology infrastructure to share data, information and knowledge
- GAC05. We have an excellent CAD/CAM system that enables effective cross-function collaboration.
- GAC06. Our department is adaptive and flexible to structural changes aimed at improving work efficiency.
- GAC07. Our organizational structure has few hierarchical barriers and between-function barriers.
- GAC08. All of us understand the job division and specialty of one another.
- GAC09. We all share common visions and goals as a group.

Teaching Motivation & Commitment (TMOT)

Reference: (Szulanski, 1996; Lyles, 1996)

- TMOT01. The Source Unit is very open for us to learn from them
- TMOT02. The Source Unit is very committed to teach us
- TMOT03. The Source Unit perceives strong benefit in helping us to develop local technical capabilities
- TMOT04. The Source Unit has a clear agenda to coordinate the knowledge transfer issues.
- TMOT05. The need for localization of the Source Unit's product or process design is strong.

Learning Motivation & Commitment (LMOT)

Reference: (Simonin, 1997; Hult, Ketchen & Nichols, 2002)

- LMOT01. Our department has a clear focus on technical capability development
- LMOT02. Our department has a clear agenda of developing technical capabilities, and has communicated it to all local personnel.
- LMOT03. We have designated personnel or task team to manage the learning process.
- LMOT04. We have invested a large amount of financial and human assets to develop engineer capabilities.

- LMOT05. The sense around here is that learning is not an option but an essential element for survival and growth.
- LMOT06. Our department has a clear focus on technical capability development
- LMOT07. We all believe that we can gain a great deal of tech capabilities from the Source Unit
- LMOT08. Gaining expertise and knowledge from the Source Unit is critical to our firm's survival

Transfer of Individual Knowledge (IK)

Reference: (Simonin, 1991)

- IK01. Improvement in advanced technologies and knowledge in individual specialties over the past 3 years
- IK02. Improvement in understanding of project management procedures over the past 3 years
- IK03. Improvement in competence of individual specialties over the past 3 years

Transfer of Group Knowledge (GK)

Reference: (Simonin, 1991 #278; Lyles, 1996; Ilgen, 1999; Lemieux-Charles et al., 2002)

- GK01. Improvement in market and customer orientation of your unit in the past 3 years
- GK02. Improvement in group culture of continuous learning in the past 3 years
- GK03. Improvement in your managers' ability to coordinate and communicate with subordinates over the past 3 years
- GK04. Improvement in coordination among people with different specialties over the past 3 years
- GK05. Improvement in intra-group communication over the past 3 years
- GK06. Improvement in group culture of team work and resource sharing over the past 3 years
- GK07. Improvement in the ability of your unit to apply advanced technical procedures to new projects that require intensive cross-functional collaboration over the past 3 years.