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Learning from complex and heterogeneous experiences: the role of knowledge codification

Loubna Echajari and Catherine Thomas

Loubna Echajari is Phd Candidate and Teaching Assistant in management science at CNRS, GREDEG, Université de Nice Sophia Antipolis, Valbonne, France. Catherine Thomas is Professor in Management at CNRS, GREDEG, Université de Nice Sophia Antipolis, Valbonne, France.

Abstract

Purpose – *The purpose of this paper is to study organizational learning from complex and heterogeneous experiences. According to March (2010), this kind of high intellect learning is difficult to accomplish because it requires deliberate investments in knowledge transfer and creation. Zollo and Winter (2002) emphasized how knowledge codification can facilitate this process, as long as it is "well-performed". However, knowledge management scholars have yet to explore what is meant by well-performed codification and how to achieve it.*

Design/methodology/approach – *This paper addresses this gap and provides a conceptual analysis based on two related but previously disconnected research areas: organizational learning and knowledge management.*

Findings – *This paper contributes to the literature in three ways. First, a new understanding of different types of experiences and their effects on learning is proposed. Then the codification process using a critical realist paradigm to overcome the epistemological boundaries of knowledge versus knowing is discussed; in doing so, it is shown that codification can take different forms to be "well-performed". Finally, appropriate codification strategies based on experience type are identified.*

Originality/value – *The abstraction-oriented codification outlined in this paper runs counter to the logic of concrete codification that dominates both theory and practice. Thus, going beyond the traditional debate on the degree of codification (i.e. should knowledge be fully codified or just partly codified), this paper introduced a new debate about the appropriate degree of abstraction.*

Keywords *Learning from experience, Organizational learning, Abstraction, Codification, Complex and heterogeneous experience*

Paper type Conceptual paper

1. Introduction

Over the past 50 years, organizational learning has been a popular research focus among management and organization scholars (Cyert and March, 1963; Argyris and Schön, 1978; Fiol and Lyles, 1985; Levitt and March, 1988; Senge, 1990; Huber, 1991; Epple *et al.*, 1991; Miner and Mezias, 1996; Crossan *et al.*, 1999; Crossan and Bapuji, 2004; Argote and Miron-Spektor, 2011). In both theoretical and empirical research, scholars have emphasized the role of experience as the first source of learning (March, 2010; Argote, 2013). Researchers have studied different types of experiences (e.g. direct, indirect, rare and failure) and the learning that ensues. However, as early as 1988, scholars warned against "superstitious learning" from experiences, especially when the links between actions and outcomes are poorly specified (Levitt and March, 1988; Levinthal and March, 1993; Zollo and Reuer, 2003). According to March (2010), the debate on the challenges and limitations of learning from experience now has renewed importance.

Organizations operate in complex, dynamic environments that greatly affect their capabilities and practices. Experiences in these environments also are evolving and complex, creating ambiguity around their role in learning support. The evolutionary nature of such experiences leads to heterogeneity, which decreases learning related to repetition.

> **"Organizations operate in complex, dynamic environments that greatly affect their capabilities and practices."**

Likewise, complexity increases causal ambiguity between actions and results, increasing the risk of superstitious learning. It therefore becomes quite difficult for knowledge to cross experiential boundaries.

Many scholars have emphasized that learning from heterogeneous and complex experiences involves the implementation of new learning mechanisms; yet, the process remains largely underexplored (Zollo and Winter, 2002; March, 2010). Indeed, early studies on learning from experience were based on simple, repetitive and successful experiences that are easily interpretable: learning is linked to the creation and accumulation of knowledge developed quasi-automatically through repetition (Zollo and Singh, 1998). These types of experiences can also lead to indirect learning through imitation (DiMaggio and Powell, 1983; Bingham and Davis, 2012). In contrast, heterogeneous and complex experiences are difficult to interpret. As such, lessons learned from experience are difficult to identify and apply to other experiences. Learning, therefore, cannot rely on automatic replication of successful practices and honing routines (Bingham and Eisenhardt, 2011), but must be based on the implementation of deliberate knowledge transfer and creation mechanisms (Zollo and Winter, 2002; Zollo and Singh, 2004; Garud et al., 2006; March, 2010).

This paper, based on a conceptual analysis, aims to further our understanding of learning mechanisms associated with complex and heterogeneous experiences by mobilizing literature on knowledge management. In doing so, we contribute to an important research stream on organizational learning, in which scholars have called for more research articulating the mechanisms associated with organizational learning and knowledge management (Argote and Miron-Spektor, 2011).

Research on knowledge management is rooted in a long-standing debate on the challenges and limits of knowledge codification (Cohendet and Steinmuller, 2000). Early studies revealed the role of knowledge codification in knowledge transfer (Zollo and Winter, 2002). Several other studies have since demonstrated that knowledge codification may be a source of organizational rigidity (Oshri et al., 2005; Vaast and Levina, 2006), making it unsuitable for knowledge creation (Ancori et al., 2000). Taking an innovative perspective, Zollo and Winter (2002) showed that knowledge codification, when well-performed, can promote knowledge creation and therefore support the implementation of dynamic capabilities. Nevertheless, the authors did not specify what is meant by well-performed codification and how to achieve it. The aim of this paper is to better understand how the implementation of adapted codification strategies can enhance learning from complex and heterogeneous experiences.

We contribute to the existing literature in three ways. First, we offer new insights into the effects of different types of experiences on learning. Then, by revisiting the codification process using a critical realist paradigm to overcome the epistemological boundaries of knowledge versus knowing, we show that codification can take different forms that can be more or less abstract. Finally, we identify the proper codification strategy for each type of experience (i.e. the form of codification that can support learning from the experience).

This article is structured in the following way. First, we provide a summary of challenges and discuss the limits of learning from experience. We discuss recent approaches that emphasize the need to deliberately and reflectively learn from complex and heterogeneous experiences. In Section 2, we examine the contributions of knowledge management literature to further our

understanding of organizational knowledge and the codification process. In Section 3, we discuss the potential role of codification in the case of learning related to complex and heterogeneous experiences. We show that proper codification enables useful knowledge to be extracted from experience and formalized so it can be applied to similar but different experiences. In other words, proper codification enables knowledge transfer from one experience to another. We conclude with some future research directions.

2. Organizational learning: role and diversity of experiences

Argote and Miron-Spektor (2011) defined organizational learning as "a change in the organization's knowledge that occurs as the organization acquires experience", emphasizing the role of experience in the process. Experience is accumulated in the organization as it performs or tries to perform tasks. Indeed, organizations learn from their attempts to perform a task, whether those tasks are complete or incomplete, and whether they are successful or fail (Argote, 2013).

Classic organizational learning theory suggests that firms learn from experience by developing and transferring routines from one experience to another (Epple et al., 1991). Recent research has revealed that tacit accumulation of experience is insufficient for learning; rather, extracting lessons from experience requires deliberate learning effort (Zollo and Winter, 2002; Zollo and Singh, 2004). Regardless, the benefits of learning through experience may be limited, and the process may actually create adverse effects (Zollo and Reuer, 2003; March, 2010). In addition, as experiences vary along many dimensions, we must understand how different types of experiences affect organizational learning (i.e. the creation and transfer of organizational knowledge) (Argote and Miron-Spektor, 2011).

2.1 Learning from direct vs indirect experiences

Organizations can learn from both direct and indirect experiences. Learning from direct experience is learning by doing (Nonaka, 1994), where performing a task improves performance in future tasks. The accumulation of direct experience through repetition builds organizational routines (Nelson and Winter, 1982). Such learning is semi-automatic (Zollo and Singh, 1998) and is a result of the creation and accumulation of knowledge through repeated experiences (Argote and Miron-Spektor, 2011) that comprise what is traditionally referred to as a learning curve (Epple et al., 1991). The mechanism favoring this automatic accumulation is trial-and-error learning. This mechanism deploys autonomously and implicitly when the organization conducts regular activities, compares the results of these activities with objectives, and revises its routines (Rerup and Feldman, 2011).

Learning based on the development of routines can have negative effects (Zollo and Singh, 2004; Sato, 2012). This type of learning can lead to myopia (Levinthal and March, 1993) when priority is placed on exploiting opportunities that are immediate (i.e. temporal myopia favoring the short term) or local (i.e. spatial myopia), but it is detrimental to the whole system. Such learning may also lead to overconfidence in factors leading to success at the expense of competence, which may induce misspecified connections between actions and outcomes. This is how learning becomes superstitious (Levitt and March, 1988; Zollo and Reuer, 2003).

Studies on learning from direct experience have focused mainly on semi-automatic learning in the production process. However, several scholars have shown that learning from direct experience is not limited to production activity, but occurs in other areas such as the formation of strategic alliances (Kale and Singh, 2007), mergers and acquisitions (Zollo and Singh, 2004),

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research and development (Pisano, 1994) and internationalization processes (Tsang, 2002; Bingham and Eisenhardt, 2011). Researchers who have studied learning from direct experience in such contexts have focused on more complex experiences, advocated more deliberate mechanisms of learning that go beyond the simple honing routines and supported the implementation of dynamic routines, all of which are crucial in changing and evolving environments (Zollo and Winter, 2002; Feldman and Pentland, 2003; Zollo and Singh, 2004; Bingham and Eisenhardt, 2011; Rerup and Feldman, 2011). However, as we will discuss in Section 3, these non-automatic mechanisms remain relatively underexplored.

Organizations also acquire knowledge from external sources (Cohen and Levinthal, 1990). These indirect experiences do not belong to the organization, but to other actors in its environment. Learning from indirect experience is called vicarious learning (Bandura, 1977), which can originate in:

■ the organization itself when activity is performed by different units;

■ organizations that are linked by formal contracts, such as alliances, which form a learning network; and

■ non-affiliated organizations (Mitsuhashi, 2011).

Through vicarious learning, organizations have the opportunity to benefit from the knowledge accumulated by others while avoiding costs associated with this accumulation (Bingham and Davis, 2012). Two main mechanisms support vicarious learning: imitation and grafting. Imitation enables an organization or any of its entities to observe the actions of others, associate this action with outcomes, extract lessons from these associations, and then select and transfer best practices internally (DiMaggio and Powell, 1983). Grafting (Huber, 1991) occurs when an organization hires new members, either through recruitment or acquisition. By definition, vicarious learning involves the transfer of knowledge developed by an organization or entity to another organization or entity (Argote and Miron-Spektor, 2011). Numerous studies have revealed the difficulties associated with transferring knowledge from one entity to another (Szulanski et al., 2004), especially when causal relationships between actions and outcomes are ambiguous (e.g. in the context of complex experiences), and when knowledge tends to be "sticky" in organizational practices (Szulanski, 1996).

Past research on direct or indirect learning was focused mainly on repetitive successful experiences performing frequent, relatively homogeneous tasks. Under these conditions, learning consists of replicating successful experiences. However, experiences are not always repetitive, simple and homogeneous. Little academic work has focused on the learning that may occur in the contexts of failure, or rare and/or heterogeneous experiences.

2.2 Learning from failures or rare experiences

Recently, researchers began to focus on learning from unsuccessful experiences (i.e. failures) (Madsen and Desai, 2010; Edmondson, 2011) and rare experiences (Lampel et al., 2009).

2.2.1 Failures. Generally speaking, failures are avoidable in predictable environments, unavoidable in complex systems, and necessary in ambiguous environments (Edmondson, 2011). Interestingly, Madsen and Desai (2010) showed that failure facilitates learning better than success by motivating actors to change their knowledge base and providing the

opportunity to extract meaningful knowledge from experience. Indeed, failure indicates to organization members that their representations of the world are inadequate and motivates them to build new ones. Thus, failure challenges the status quo and induces decision-makers to deeply and consciously engage in cognitive processes involving complex thought. Failure indicates not only the existence of an organizational knowledge gap, but also where it exists. As such, failure provides a roadmap showing where organizational efforts will be most productive. In this sense, large failures are more favorable than small ones. However, failures, especially large ones, occur rarely. Thus, organizations must learn from the failures of others and from rare experiences.

2.2.2 Rare experiences. Learning from rare experiences has received minimal scholarly attention, and as such, it does not have a formal conceptual framework (Lampel *et al.*, 2009). Lampel *et al.* (2009) identified two types of learning from rare experiences in general:

1. learning that occurs during a rare event; and

2. learning that occurs after a rare event.

The first is an emerging learning that manifests as unexpected and improvised analysis in real time (Miner *et al.*, 2001). It is therefore linked to direct experience. The second is learning from the consequences or the products of a specific rare event such as an accident or acquisition; it can be produced from a direct or indirect experience (Lampel *et al.*, 2009). However, as noted by March (2010, p. 1), "Organizations learn from experience, but learning seems problematic when history offers only meager samples of experience".

Rare experiences challenge traditional approaches of organizational learning based on progressive improvement of responses to known categories of experiences (Garud *et al.*, 2011). Indeed, recognizing, interpreting and analyzing rare experiences require the development of new conceptual categories. In addition, facing rare events with strong causal ambiguity increases problems associated with superstitious learning. As noted by Zollo (2009), individuals and organizations tend to develop future aspirations by retrospectively interpreting rare experiences from the past. These retrospective interpretations may be selective and biased, and induce superstitious learning. Finally, a rare experience is never repeated in exactly the same way. Reusing knowledge generated by a rare experience raises the problem of recognizing a suitable level of similarity between the present experience and a prior rare experience (Zollo and Reuer, 2010). Once similarity is recognized, the past experience does not determine the response *per se*, but instead informs new thinking and actions (Garud *et al.*, 2011). In this context, this type of learning involves both knowledge transfer and knowledge creation. Thus the distinction between indirect experience (knowledge transfer) and direct experience (knowledge creation) becomes less relevant.

Scholars have shown the utility of implementing deliberate learning processes to learn from rare experiences (Lampel *et al.*, 2009; Zollo, 2009). These deliberate learning processes can be applied to direct or indirect rare experiences after they occur to help organizations identify the original causes of events and avoid problems associated with superstitious learning (Zollo, 2009; Garud *et al.*, 2011).

Finally, we want to underline that, in the literature, rare experiences' definitions are quite varied, ranging from highly exceptional experiences (Kim *et al.*, 2009) to somewhat relatively rare (Zollo, 2009). We suggest that relatively rare experiences refer to complex and heterogeneous experiences and constitute a particular category of experience that deserves to be studied separately.

2.3 Learning from complex and heterogeneous experiences

2.3.1 Ambiguities associated with learning. Few scholars have studied learning that may occur from complex and heterogeneous experiences, because such experiences are

relatively rare, challenge the traditional principle of learning curves and are less generalizable to other contexts (Zollo and Reuer, 2010). Drawing on Simon's (1962) groundbreaking work on complexity, we define a complex experience as being composed of a large number of parts that interact in non-simple ways. Complexity reinforces the ambiguity of learning and induces an inability to recognize relevant variables and their functional relationships, both of which increase the risk of superstitious learning. March (2010, p. 45) mentioned that learning under these conditions involves "transforming the ambiguities and complexities into a form that is elaborate enough to elicit interest, simple enough to be understood, and credible enough to be accepted".

Heterogeneity is related to the fact that complex experiences, such as acquisitions, are never repeated in the same way. As seen above, for relatively rare experiences the challenge is double. On the one hand, organizations must be able to recognize the similarities between experiences in order to transfer knowledge from one experience to another. On the other hand, organizations must be able to adapt knowledge that has been produced in a given context to similar, but constantly evolving contexts.

These limitations raise the question of the role of experience in learning within dynamic environments characterized by complex and heterogeneous experiences. Recently, scholars have specifically sought to understand how to learn from complex and heterogeneous experiences (Garud et al., 2006; March, 2010; Bingham and Eisenhardt, 2011; Bingham and Davis, 2012). Bingham and Davis (2012) emphasized that learning from a complex and heterogeneous experience involves combining different mechanisms and types of learning. They suggested combining three learning mechanisms associated with direct experience: trial and error, experimentation and improvisation. This process, called soloing, is especially effective at the beginning of the learning process. They also highlighted a new process called seeding, which combines learning from both direct and indirect experiences and leads to better long-term performance. Thus, learning from complex and heterogeneous experiences requires activating mechanisms of extraction, accumulation, and creation of new organizational knowledge; in other words, such experiences induce deliberate learning.

2.3.2 Need to develop deliberate learning. As noted by March (2010, p. 104), experience is an imperfect teacher, especially when it is complex and heterogeneous, because it is difficult to extract and reuse such knowledge. Experience alone, then, is insufficient; it must be complemented by the implementation of deliberate and reflective learning processes (Zollo and Winter, 2002). Studies focused on complex, heterogeneous experiences such as mergers and acquisitions (Zollo and Singh, 1998; Zollo and Singh, 2004), alliance formation (Kale and Singh, 2007), internationalization (Bingham and Davis, 2012) and new product development (Miner et al., 2001) have sparked a number of additional research directions.

Learning from heterogeneous and complex experiences has been described as a high intellect (March, 2010) or mindful (Argote, 2013) process. In contrast to low intellect learning based on stimulus–response, success replication and adaptation, high intellect learning processes develop explicit understandings of experience (March, 2010). These lessons are designed to produce a causal explanation through narratives, models or theories and rely on analogical reasoning based on a comparison of several cases to extract common principles (March, 2010; Argote, 2013). Studying the underlying causes helps organizations avoid superstitious learning.

In a quite similar perspective, the second research avenue emphasizes the need to extract generic and abstract principles from experience. Garud et al. (2006, p. 279) defined the concept of learnability as the "ability to go beyond the specifics of a situation to derive abstract concepts and generic principles". Unlike learning by doing, learnability is the potential to generate new knowledge through reflection in action. Reflection in action

occurs when individuals seek causal mechanisms by asking why or why not to develop and construct approximate conclusions or tentative hypotheses (Garud *et al.*, 2006).

The last research stream focuses on the role of knowledge codification in deliberate learning. Past research has shown the positive role of codification in learning from complex and heterogeneous experiences such as mergers, acquisitions or alliances (Zollo and Winter, 2002; Zollo and Singh, 2004; Kale and Singh, 2007). According to these scholars, organizations are forced to go beyond the mere accumulation of experiences and instead build effective capabilities about generalizing an experience from one deal to the next. These capabilities are develop "by capitalizing on the efficiency that codification affords while simultaneously avoiding the rigidity it breeds" (Heimeriks *et al.*, 2012, p. 719). In these contexts, knowledge codification helps companies "see through the fog" of causal ambiguity associated with complex experiences by facilitating the identification of causal relationships that explain performance outcomes (Zollo and Winter, 2002; Heimeriks *et al.*, 2012). These scholars stressed that to generate beneficial effects of codification, it must be "well-performed", i.e. avoid the rigidity it breeds. However, they did not specify how to achieve this.

While knowledge codification can yield significant benefits, numerous studies have revealed that codification also can increase rigidity and limit an organization's ability to effectively adapt routines to specific situations (Oshri *et al.*, 2005; Vaast and Levina, 2006). Other researchers have found ambiguous effects; while knowledge codification can be positive during some phases of alliance formation, such as partner selection and partnership implementation, it can be useless during other phases, such as alliance management (Heimeriks *et al.*, 2014).

This raises an interesting conundrum. Given the ambiguous results of empirical studies, it is still unclear whether the problem is knowledge codification or how it is performed. We suggest that a key to this conundrum lies in considering contributions from the knowledge management literature to deepen the codification process. Table I provides a summary of research on the issues and limitations of learning through experience.

3. Knowledge codification strategies: contributions from the knowledge management literature

Deliberate learning requires developing and implementing processes that encourage organizational knowledge transfer and creation (i.e. knowledge management). In this section, we present the contrasting perspectives that are debated in this field, and position our work within the knowledge management literature. We then focus on the codification process that is central to knowledge management practices to consider its potential contribution to learning from complex and heterogeneous experiences.

3.1 Organizational knowledge: contrasting perspectives

Researchers generally study organizational knowledge from either a cognitive or a practice-based approach. Their divergence is rooted in the very definition of knowledge. Without engaging in a philosophical debate, we outline the main differences between these approaches, their implications for knowledge management and their convergence points to position our perspective.

3.1.1 Divergent approaches. The cognitive approach, also called an epistemology of possession, focuses on individual cognitive processes and favors a positivist approach of knowledge. From this perspective, knowledge is defined as "justified true belief" (Nonaka, 1994, p. 15) that represents the world "as it is" (Tsoukas and Mylonopoulos, 2004); knowledge is, therefore, an iconic correspondence with the world (Lorino, 2007). From a cognitive perspective, an individual's tacit knowledge that is accumulated during experiences can be codified – that is, described by codes and symbols to be made explicit (Cowan *et al.*, 2000). Once codified, knowledge becomes an object or a property that can

Table I Literature on organizational learning based on experience type

Experience	Repetitive, simple and positive		Heterogeneous and complex		Rare (failure or success)	
Direct (learning by doing)	Routines	Nelson and Winter (1982)	Deliberate learning (knowledge transfer and creation) Trial-error- Improvisation- Experimentation	Miner and Mezias (1996)	Emergent learning, deliberate learning	Lampel et al. (2009)
	Superstitious learning	Levitt and March (1988) Zollo and Reuer (2003)		Miner et al. (2001)	Superstitious learning	Zollo (2009)
	Learning curves (trial and error)	Argote et al. (1991) Pisano (1994) Argote (2013)		Bingham and Davis (2012)	Appropriate level of similarity	Zollo and Reuer (2010)
	Myopia	Levinthal and March (1993)			Deliberate learning, new conceptual categories, new actions	Garud et al. (2011)
	Semi-automatic learning	Zollo and Singh (1998)	Dynamic routines	Pentland and Feldman (2003) Rerup and Feldman (2011)		
	Low intellect learning	March (2010)	Positive role of codification	Zollo and Winter (2002) Zollo and Singh (2004)		
	Learning by knowledge creation	Argote and Miron-Spektor (2011)				
Indirect (vicarious learning)	Imitation	DiMaggio and Powell (1983) Yang et al. (2010) Bingham and Davis (2012)	Negative role of codification	Kale and Singh (2007) Oshri et al. (2005) Vaast and Levina (2006)	Learning from others' failures	Baum and Dahlin (2007)
	Superstitious learning	Levitt and March (1988) Zollo and Reuer (2003) Huber (1991)	Learnability, Reflection in action	Garud et al. (2006)	Superstitious learning	Zollo (2009)
	Grafting		High intellect learning	March (2010)	Large amplitude failure as vector learning	Madsen and Desai (2010)
	Sticky knowledge	Szulanski (1996)	Mindful learning	Argote (2013)	Appropriate level of similarity	Zollo and Reuer (2010)
	Causal ambiguity	Szulanski et al. (2004)				
	Motivation, learning capacity, confidence	Szulanski et al. (2004)				
	Deliberate learning by transfer	Argote and Miron-Spektor (2011)	Ambiguous role of codification	Heimeriks et al. (2014)		

be stored and transferred using various organizational tools. This knowledge conversion from tacit to explicit and from individual to collective is at the core of the spiral of organizational knowledge creation (Nonaka, 1994). The definition of knowledge as *the* representation of the world *as it is* implies that codified knowledge is a "pure substitute" for tacit knowledge (Ancori *et al.*, 2000, p. 257). This perspective emphasizes codified knowledge and its corollary, technical approaches to knowledge management within organizations. A semantic Web based on ontologies defined as "a set of concepts needed to describe an area" (Nevo and Wand, 2005, p. 554) is a perfect illustration of this perspective.

This cognitive approach has been strongly contested by scholars who favor an epistemology of practice (Brown and Duguid, 2001; Gherardi, 2001; Nicolini *et al.*, 2003) and reject a definition of knowledge based on "realness", but instead seek to understand its procedural and dynamic aspects (Newell *et al.*, 2009). These scholars use a definition of knowledge that recognizes it as *a* representation of the world based on the linguistic categories that have been institutionalized and adopted by a particular community (Tsoukas, 2000). This definition is rooted in constructivist, pragmatic or realistic criticism epistemological paradigms. From this perspective, knowledge does not provide a representation of the world as it is, but as always incomplete and socially situated. Finally, they point out that knowing is not a purely cognitive activity; it is also physical in that we can learn from our bodies (Tsoukas and Mylonopoulos, 2004).

The processual and dynamic aspects of knowledge are apprehended through the words "knowing" or "knowledge in action" and are based on three principles:

1. knowledge is built and mired in practice;

2. knowledge has many contextual elements and, therefore, is difficult to extract from practices, which are socially situated in broader organizational contexts; and

3. in their practices, players use not only words and concepts but also tools and objects that interact with the practices and organizational contexts (Newell *et al.*, 2009).

This perspective emphasizes tacit knowledge and social approaches to knowledge management as communities of practice.

3.1.2 Reconciliation efforts. According to Cook and Brown (1999), knowledge and knowing should not be seen as competing, but as complementary. Knowledge is information about a phenomenon, while knowing is dynamic, practical and relational, and it is an integral part of action. From this perspective, knowledge is a tool that enables concrete interaction with the world. Likewise, the knowing that is developed through interaction can enrich the knowledge used in practice. Therefore, those who study the dynamics of knowledge in organizations are assumed to be interested in both knowledge (i.e. what they possess) and practices that mobilize it (i.e. what they do) (Cook and Brown, 1999).

Building on Cook and Brown (1999), Nonaka and von Krogh (2009) revisited the interaction between tacit and explicit knowledge in connection with an epistemology of practice. Recognizing that the terms "justified true belief" and "conversion" (Nonaka, 1994) were sources of confusion in the debate on the creation of organizational knowledge, these authors further clarified the scope of their theory. First, knowledge is not defined as iconic correspondence with the world. On the contrary, knowledge and justification must be defined using a pragmatic approach, in connection with actions. Second, knowledge is socially situated and, therefore, knowledge creation is strongly influenced by the organizational context wherein it develops. Furthermore, tacit and explicit knowledge are not substitutes, but complements that interact, transform and enrich each other. In particular, Nonaka and von Krogh (2009) emphasized the creative aspects of articulation and codification that enrich organizational knowledge, aspects too often neglected by proponents of an epistemology of practice. Nevertheless, they recognized that in organizations, processes of tacit and explicit knowledge transformation and interaction

cannot be analyzed independent of the social contexts in which they take place, a point that initially had been neglected by Nonaka (1994). It is clear that, in practice, focusing solely on either technical approaches or social approaches provides unsatisfactory results (Newell *et al.*, 2009). In the tradition of Cook and Brown (1999) and Nonaka and von Krogh (2009), we wish to reconcile these two approaches. But to do this, we propose to re-conceptualize the process of codification based on the epistemological critical realist paradigm.

3.2 Reconsidering the knowledge codification process

We adopt a definition of knowledge broad enough to integrate aspects of individual cognition with its social nature. Knowledge is defined as an individual's ability to make distinctions in a field of collective action, based on an appreciation of context, theory or a combination of both (Tsoukas and Vladimiriou, 2001). Organizational knowledge may then be defined as:

> [. . .] the capability members of an organization have developed to draw distinctions in the process of carrying out their work, in particular concrete contexts, by enacting sets of generalizations whose application depends on historically evolved collective understandings (Tsoukas and Vladimiriou, 2001, p. 973).

In addition, we favor an approach in which tacit and codified knowledge are seen as complementary and interacting (Ancori *et al.*, 2000; Nonaka and von Krogh, 2009). Within organizations, knowledge inherently includes tacit knowledge that cannot be codified; thus, codified knowledge needs to be used tacit knowledge. Nevertheless, we, along with many other scholars (Boisot, 1998; Cowan *et al.*, 2000; Hakanson, 2002; Boisot and Li, 2005; Nonaka and von Krogh, 2009) emphasize the key role of codification in organizational knowledge creation and especially in knowledge management practices. From this perspective, the codification process is complex and not neutral; mutual and recursive influences arise among the codification, structuring, and knowledge creation processes (Thomas, 2006).

3.2.1 Knowledge codification: a complex process. Defining knowledge as the ability to draw distinctions involves the construction and deployment of a system of codes or categories essential to capturing and representing phenomena (Boisot and Li, 2005). The coding then consists of deliberate efforts to represent knowledge using codes and socially shared symbols; these codes include images, maps and all symbolic forms used in language (Hakanson, 2002). In this context, the codification process is not neutral. Building a system of codes or socially shared categories requires negotiation processes within the communities involved. Likewise, studies on organizational attention (Ocasio, 2011) and sensemaking (Weick and Kathleen, 2006) have shown that deploying this system of codes within a community will influence how the actors in the community will discriminate and represent the phenomena. Finally, building a system of codes or categories to represent a phenomenon extends knowledge through the creation of new concepts (Nonaka and Takeuchi, 1995) and the facilitation of knowledge exchange and combination (Nahapiet and Ghoshal, 1998).

Codification is based on two processes:

1. a process of differentiation or discrimination that enables different categories to be clearly distinguished so as to capture the different aspects of a concrete phenomenon, and thus be able to distinguish different phenomena from each other; and

2. a process of association or integration, by which different categories are combined into more abstract categories in order to obtain a representation that is both simplified (i.e. fewer categories) and structured (Boisot and Li, 2005).

The first process, articulating and codifying tacit knowledge, is not easy. Indeed, as Polanyi (1962) stated, some tacit knowledge cannot be articulated, and some is not even worth codifying. If the differentiation process shapes the phenomenon, the abstraction process

provides the structure that facilitates the communication and dissemination of knowledge (Boisot and Li, 2005).

Abstraction plays a leading role in the process of codification. In abstraction, different things are treated as if they were identical. The integration of different concrete categories into a more abstract homogeneous category can be achieved through statistical or analytical correlation (Boisot and Li, 2005). The critical realist perspective emphasizes the analytical approach. According to Bhaskar (1978), reality is stratified and comprised of three ontological levels:

1. the real domain wherein the generative structures and mechanisms exist;

2. the actual domain, which comprised events or patterns of events that occur in time and space; and

3. the empirical domain, which comprised experienced events.

While the empirical domain is observable, the domain of structures and underlying generative mechanisms is not (Tsoukas, 1989). Abstraction, then, consists of proposing a representation of the structures and generative mechanisms at the origin of the observed events. Of course, knowledge or abstract descriptions that we can elaborate about real underlying structures and generative mechanisms are dependent on linguistic categories institutionalized and adopted by a community; in addition, they are not completely independent of theories and conceptual frameworks that the actors who elaborate them mobilize explicitly and/or implicitly (Tsang and Kwan, 1999). These representations guide and are tested in and through action. Thus, several forms of codification can be developed that are more or less abstract depending on the objectives of the codification process.

3.2.2 Codification and abstraction: various strategies. Various codification strategies – some more abstract, others less so – may exist within the same organization. They depend on organizational context and especially its culture, the cognitive styles of the agents responsible for the codification and their objectives (Boisot and Li, 2005).

The purpose of concrete codification is to provide the fullest possible representation of the observed phenomenon, which seems particularly appropriate in the case of simple, repetitive tasks. Once a task or phenomenon becomes complex, however, concrete codification will require a large number of categories and interrelationships, making the codified knowledge difficult to disseminate and communicate (Boisot and Li, 2005). Furthermore, this complexity leads to different concrete manifestations that cannot be applied to other contexts, making concrete codification inoperative. Indeed, the concrete codes and interrelationships required to represent a phenomenon will differ from one context to another.

For representing a complex phenomenon, abstract codification provides two advantages:

1. it limits the number of codes required to represent the phenomenon; and

2. it reveals the phenomenon's underlying structure.

Both elements facilitate the dissemination and the communication of knowledge (Boisot and Li, 2005) and make it applicable in many contexts, which change over time and space. Indeed, structures and generative mechanisms that constitute the real domain have greater stability than events that occur in the actual domain (Bhaskar, 1978). However, abstract codifications generate a loss of accuracy in the representation of phenomena, requiring the actors who wish to appropriate this knowledge to expend major effort on re-contextualization. This ability to re-contextualize abstract knowledge is partly based on an actor's tacit knowledge. Therefore, abstract codification strategies reinforce the necessary interactions between tacit and codified knowledge.

4. Knowledge codification strategies in deliberate learning

As shown in Table I, besides learning from simple and direct experience, learning is usually deliberate and involves codification effort. However, from one experience to another, contexts change, the cognitive styles of the agents responsible for codification differ and objectives vary. As discussed in Section 2, this leads to the use of different codification strategies which are more or less abstract. Thus, based on the theoretical findings described in Sections 1 and 2, in this section, we propose a knowledge codification strategy for each experience type (Table II).

4.1 Codification strategy for repetitive, simple and positive experiences

For repetitive, simple and indirect experiences, learning efforts entail copying successful practices associated with positive experiences in one location and applying them identically in another location. Thus, knowledge codification in such contexts is focused mainly on executing mundane tasks (e.g. baking a pizza) and standardizing practices (Bingham and Eisenhardt, 2006).

4.1.1 Concrete codification strategy. Codifying the "know-how" required to transfer best practices without needing to understand their causal ambiguities requires many concrete categories to identically replicate all aspects of a phenomenon (i.e. practice). Typically, this knowledge is easier to transfer to a similar context (Zollo and Singh, 1998) and is based on documents, repositories and knowledge databases. Therefore, a concrete knowledge codification strategy is appropriate for simple, repetitive and indirect experiences.

4.1.2 Examples of concrete codification. In their popular research paper about knowledge transfer, Darr *et al.* (1995) described tasks in the pizza production process for a pizza franchise store. In this context, the execution of tasks is simple and repetitive. One example cited by Darr *et al.* (1995) concerns the layout for the workflow, which is the final step in the pizza production process. The authors described how a "better boxing arrangement was discovered that involved placing opened boxes horizontally on a large table near the pizza oven" (Darr *et al.* (1995), p. 1752) to facilitate coordination between the phone operator who takes orders from customers and the pizza maker:

> This arrangement allows a pizza maker to read the label in its natural position and to move a finished pizza directly from the oven into the box. The new boxing arrangement saves time and reduces waste from dropped pizzas (Darr *et al.* (1995), p. 1752).

Table II Potential codification strategies based on experience type			
Experience	*Repetitive, simple and positive*	*Heterogeneous and complex*	*Rare (failure or success)*
Direct (learning by doing)	Semi-automatic Learning ↓ No need to codify (Zollo and Singh, 1998)	Deliberate learning (Knowledge transfer and creation) ↓	Deliberate learning (Knowledge transfer and creation) ↓
Indirect (vicarious learning)	Deliberate learning by transfer (Knowledge Transfer) ↓ Concrete codification of "know-how" (procedures) (Bingham and Eisenhardt, 2011)	Abstract codification of "know-how" and "know-why" Role of abstraction (Boisot and Li, 2005). Reflection in action (Garud *et al.*, 2006) Codification of "know-why" (Garud *et al.*, 2006; Kale and Singh, 2007; Zollo, 2009 Rational heuristic and simple rules (Bingham and Eisenhardt, 2011)	Abstract codification of "know-why" and concrete codification of "know-how" Safety procedures (Madsen, 2009)

This example suggests that the best way to transfer this solution to other franchise units would be to codify it in a concrete manner by fully describing the procedural knowledge necessary to accomplish the task. Otherwise, the procedure might not be replicated.

We also want to emphasize that the concrete codification perspective dominates the literature (Bingham and Eisenhardt, 2006). The codification debate essentially concerns the degree of codification (i.e. must the knowledge be fully codified or just partly codified). As we showed in Point 2, the core question about codification relates to the appropriate degree of abstraction (Boisot and Li, 2005).

4.2 Codification strategy for heterogeneous and complex experiences

As we have shown above, in the context of complex and heterogeneous experiences, learning is based on complex cognitive mechanisms (i.e. high-intellect mechanisms; March, 2010) that produce explicit understanding (i.e. a causal explanation of the events comprising the experience) (Garud *et al.*, 2006). Indeed, the knowledge created in the context of complex and ambiguous experiences may be incorrect (superstitious learning) and knowledge from past experiences cannot be transferred identically to new experiences. The distinction between direct (knowledge creation) and indirect (knowledge transfer) experience is therefore less prominent than for simple experiences that are repeated over and over again. Indeed, whether a complex experience is direct or indirect, learning is always based on both knowledge transfer (in time, from one experiment to another; and/or in space, from one entity to another) and knowledge creation (using past knowledge to deliberately create new knowledge in the action). Recent work then suggests a positive role of codification in both knowledge transfer and creation (Zollo and Winter, 2002; Zollo and Singh, 2004; Kale and Singh, 2007).

4.2.1 Abstract codification strategy. The codification effort must therefore relate to the causes of success or failure (Kale and Singh, 2007; Zollo, 2009) and bring forth a clearer picture of what works and what does not work. By revealing the "know-why", codification reduces the causal ambiguity associated with complex experiences (Heimeriks *et al.*, 2012) and therefore improves related learning. But, to reuse lessons from complex and heterogeneous experiences, knowledge must be well-codified. The central question that arises, therefore, is how to appropriately codify complex and heterogeneous experiences. These lessons must be applicable to different experiences because such experiences are inherently heterogeneous. Knowledge codification should also, therefore, ensure reuse. According to Boisot and Li (2005), abstract codification seems more appropriate for complex and heterogeneous experiences. Indeed, abstraction enables the underlying structure (i.e. the "know-why") of the phenomena to be represented; using abstract codes extends their applicability to different contexts and thus facilitates the reuse of codified knowledge in changing conditions.

4.2.2 Examples of abstract codification

4.2.2.1 Simple rules. In the case of complex and heterogeneous experiences related to internationalization processes, Bingham and Eisenhardt (2011) demonstrated the importance of capturing the causal mechanisms that shape experience, and developing heuristics to guide action. Heuristics provide a common structure for a series of related issues through the abstract codification of why and how, but provide little detail on specific solutions. In contrast, procedures (the concrete codification of know-how) would provide limited explanation of the structure of the phenomenon, while providing many details about solutions. Therefore, these heuristics should be coded as simple rules (Bingham and Eisenhardt, 2011). This simplicity is achieved through a process of progressive abstraction, in which heuristics are first defined in a concrete way and then integrated into more general and abstract rules. This simplification cycle enables organizations to develop and maintain a relatively small portfolio of abstract rules that are easy to share and allow great flexibility in action. Indeed, these rules guide, but do not determine the solutions to be implemented;

they are created in and through action in different contexts. For example, the authors identified a temporal heuristic "move from tier-three to tier-two to tier-one countries" (Bingham and Eisenhardt, 2011, p. 1451). Indeed, after identifying the mechanisms behind successful internationalization in the past, executives elaborated the rule:

> The firm should (1) sell in "tier-three" countries like Taiwan and then (2) use those reference accounts to gain customers in "tier-two" countries like Korea. After gaining "tier-two" customers, the firm should then (3) use those accounts to enter "tier-one" countries like Japan (Bingham and Eisenhardt, 2011, p. 1451).

4.2.2.2 Abstract models. Likewise, in their study of complex and heterogeneous product development processes, Garud et al. (2006) showed how Infosys[1] codified organizational knowledge through models to foster dynamic capabilities and innovation. These models are:

> [. . .] bundles of assumptions, constructs, experiences, and working hypotheses, ranging from a model of customer relationships, defining ways to interact with clients, to a global delivery model, defining how Infosys distributes software development tasks globally (Garud et al., 2006, p. 279).

These models are the source of the company's innovation capacity; the human resources director emphasized that "the ability of employees to appreciate, develop and evolve with these models was critical for the advancement of their careers" (Garud et al., 2006, p. 279).

In sum, the two examples cited above suggest that what organizations learn from heterogeneous and complex experience is generic and abstract knowledge. Codifying this knowledge in an abstract manner (i.e. by creating abstract rules) allows managers to both guide action and enable improvisation (Bingham and Eisenhardt, 2006). In line with Boisot and Li (2005) and Bingham and Eisenhardt (2006), we offer a different view of codification based on integrating various levels of abstraction. This raises an interesting question about knowledge codification in practice: What is the appropriate degree of abstraction?

4.3 Rare experiences

For rare experiences, the goal of implementing deliberate learning is to be able to recognize causal factors in the future by assigning predefined categories to avoid repeating negative experiences (i.e. accidents) (Christianson et al., 2009; Madsen, 2009) or to reproduce factors of successful experiences (i.e. excellent performance) (Kim et al., 2009).

4.3.1 A strategy combining concrete and abstract codification. Reproducing successful rare experiences should be based on capturing "why" the experience succeeded. As with heterogeneous and complex experiences, here the codification must ensure the application of knowledge to different experiences, since the rare successful experience might never happen again. Knowledge codification should be abstract as in the case of heterogeneous and complex experiences.

However, in the case of rare negative experiences, the codification effort is double: identify the causes of the accident (know-why) and then develop concrete procedures to prevent it from happening again (know-how). While Madsen and Desai (2010) highlighted the difficulty associated with extracting meaningful knowledge from such experiences, abstract codification in the form of simple rules, heuristics or models should help actors structure their experiences to capture some benefits. On the other hand, concrete codification should help an organization avoid reproducing an accident, for instance, by implementing new safety procedures.

4.3.2 Example of a combined codification strategy. In his study of learning in the context of US coal mining disasters, Madsen (2009) emphasized that organizations can learn and "reduce their likelihood of future disaster through direct experience with disaster, direct experience with minor accidents, and vicarious experience with disaster" (Madsen, 2009, p. 872). The codification process has two main steps:

1. an organizational expert codifies new safety models (abstract codification of the know-why and know-how); and

2. using these revised models, managers codify a set of organizational safety procedures (concretes codification of the know-how) to implement new organizational safety routines.

This example outlines the complementarity of different forms of codification with different levels of abstraction, echoing Boisot and Li (2005).

In Table II, we summarize knowledge codification strategies for deliberate learning based on experience type, as discussed in this section.

5. Conclusion

This article was intended to enrich our understanding of learning mechanisms associated with complex and heterogeneous experiences. In doing so, we answered a call for research from Argote and Miron-Spektor (2011) to link and combine two fields of related research that had yet to be connected: organizational learning and knowledge management. We accomplished this goal by revisiting the concept of codification using the critical realist paradigm to overcome epistemological boundaries between knowing and knowledge. Further analysis of the codification process, particularly of the key role of abstraction, has greatly enriched our understanding of deliberate learning mechanisms required for complex and heterogeneous experiences.

In these cases, the lessons of experience are difficult to both extract and reuse. Learning cannot, therefore, be based on the replication of successful practices and the gradual development of routines. They are based on the implementation of deliberate learning mechanisms in which the processes of codification and abstraction play important roles. Recent studies have shown that these complex mechanisms of knowledge transfer and creation are based on the development and dissemination of abstract rules. These abstract rules describing the underlying structure of the studied phenomenon act as referents that both guide action and enable improvisation.

To summarize, we have made three interrelated contributions. First, following Boisot and Li (2005), we have introduced the notion of abstraction to show that knowledge codification can take different forms which are more or less abstract. This abstraction-oriented codification runs counter to the logic of concrete codification that dominates both theory and practice. Thus, going beyond the traditional debate on the degree of codification (i.e. should knowledge be fully codified or just partly codified), we have introduced a new debate about the appropriate degree of abstraction. Finally, we have identified the strategy of codification that can support learning from each type of experience.

Beyond our theoretical contributions, we hope that the present paper provides useful guidance for future empirical inquiry into the role of abstraction within knowledge codification processes associated with learning from heterogeneous and complex experiences. We know little, for example, about how accomplish the right mix between abstraction and accuracy in different contexts to ensure that well-codified rules are created. What is the social dimension of the construction of concepts that will enable the development of well-codified knowledge? And how can an actor's capacity be developed to combine abstract rules in action and to re-contextualize them in a flexible manner? As pointed out by Heimeriks et al. (2012), research on experience codification is still in its infancy.

Note

1. Infosys Technologies Ltd. is an Indian company providing IT services.

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About the authors

Loubna Echajari is a Doctoral Student and teaching assistant in management science at Nice Sophia Antipolis University and a member of the GREDEG (Groupe de Recherche en Droit, Economie et Gestion, UMR 7321, CNRS) research center. Loubna's research interests focus on understanding the role of knowledge codification within deliberate organizational learning processes. Loubna Echajari is the corresponding author and can be contacted at: loubna.ec@gmail.com

Catherine Thomas is Professor in Management at the Nice Sophia Antipolis University (France) and a member of the GREDEG (Groupe de Recherche en Droit, Economie et Gestion, UMR 7321, CNRS) research center. Her current research interests include strategic organizing and knowledge management. She has coordinated an interdisciplinary project "Knowledge Management Platform" whose objective was to develop and implement a competence based web site for a network of firms and research institutions in the telecommunication industry.