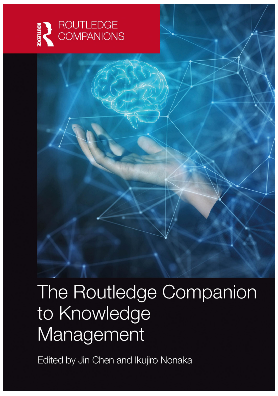

The Routledge Companion to Knowledge Management

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Is There Empirical Knowledge? An Observation Based on Clinical Medicine

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IS THERE EMPIRICAL KNOWLEDGE? AN OBSERVATION BASED ON CLINICAL MEDICINE

Jin Chen, Juxiang Zhou and Yang Yang

Definition and Characteristics

Definition of Knowledge

Knowledge is a broad and abstract concept, which was first defined in philosophy. Plato, the Ancient Greek philosopher, first defined "knowledge" in *Meno* and analyzed the difference between correct opinions and knowledge in *Theaetetus*. Plato argued that knowledge was composed of three necessary conditions, i.e., belief, truth, and justification, namely justified true belief. Although this concept has triggered considerable controversy for its logical flaws, it still occupies a dominant position in Western philosophy (Nonaka and Takeuchi, 1995). Then, Locke proposed that knowledge was rooted in experience, and all knowledge comes from experience. However, with the publication of *Is Justified True Belief Knowledge* by Edmund L. Gettier (1963), the traditional view that "knowledge comes from experience" was fundamentally challenged, and the rationality of empirical knowledge arising from the unique or non-reproducible experience was questioned. With the advance of the times, the traditional view on knowledge has gradually evolved to hold renewed definitions and connotations. For instance, Piaget, a constructivism master, reckoned that knowledge was a subjective existence, which was proactively built by the subject based on his or her own experience and the social/cultural/historical context to mingle with the subject world. Postmodernists then pointed out that knowledge was a mathematical symbol system of experience, information, tools, logic, and ideas that were conducive to the survival and development of mankind as generated in activities. There is no such thing as truth or universality with uncertainty (Lu and Chen, 2008). Due to the multi-faceted nature and uncertainty of knowledge, scholars at home and abroad have not yet reached a unified definition. No matter how it changes, the definition invariably centers on the processes of learning, perception, and sublimation. For example, in *Webster's Dictionary*, knowledge is the cognition of facts or states obtained through practice, research, connection or investigation, and the understanding of science, art, or technology, incorporating the sum of perception of truths and principles acquired by human beings.

The definition of knowledge makes sense only in a specific era. In today's era of the knowledge economy, Peter Drucker's definition is more widely accepted. Drucker argued

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that knowledge was the information capable of changing certain people or things – this includes basic methods to transfer information into action and ones that enable individuals or institutions to improve or enhance efficiency by using information.

Characteristics of Knowledge

The characteristics of knowledge refer to the ordinary things shared by different types of knowledge. In traditional theories, knowledge is considered to be homogeneous. All knowledge can be transferred, communicated, and shared (Guo, 2010). However, with the deepened knowledge research, its transferable, highly contextualized, and path-oriented nature has been proposed and received significant attention. The characteristics of knowledge directly determine the effects of technological innovation and production & operation, serving as one of the essential bases for classifying the knowledge types. The views of some scholars at home and abroad on the characteristics of knowledge are summarized in Table 19.1.

Based on the above analysis, entity knowledge and process knowledge are referenced. Basic understanding of knowledge in management science, especially dynamics and validity of knowledge in the modern view, is absorbed to define it as elements conducive to completing various activities obtained through thinking, including concepts, meanings, principles, know-hows, beliefs, insights, and practical understanding. As fruits of human cognition and all perception and experience acquired during people's understanding and changing of the world, it incorporates knowledge owned in the sense of stock and knowing of practical actions.

Table 19.1 Literature on characteristics of knowledge

Study investigator	*Characteristics of knowledge and description*
Zander and Kogut (1995)	Five characteristics: codifiability, teachability, complexity, system dependence, and observability
Teece (1996)	Seven characteristics: uncertainty, path dependency, cumulativeness, irreversibilities, technical inter-relatedness, tacitness, and inappropriability
Sveiby (1997)	Tacit, action-oriented, rules-based, individual, and constantly changing
OECD's Annual Report in 1996 The Knowledge-based Economy	Five characteristics: practicality, implicitness, sharing, irreversible reusability, and metabolism
He, Xiong, and Liu (2005)	Seven characteristics: originality, stability, genetic variability, dominance, hermeticity, compatibility, and environmental adaptability
Zhang and Ni (2005)	Three characteristics: conscientiousness or implicity, context-dependence, and comprehensiveness
Zhang (2008)	Three characteristics: continuous accumulation, qualitative change and its irreversibility, and increasing returns to scale

Source: Based on articles by Guo Aifang (2010) with reference to other relevant literature

Classification of Knowledge

Overview on Knowledge Classification

The rapid development of modern science is closely related to the maturity of taxonomy. Knowledge is an essential part of human culture, and its detailed classification is the basis for further in-depth study of its essence, connotation, and management. Knowledge classification is a system that divides all human knowledge into different categories by specific needs and standards through comparison according to attributes such as correlation, difference, and sameness, to show its proper position and interaction in the overall knowledge. However, knowledge classification is a very complex cognitive activity. Due to the difference in individual cognition, goals, and perspectives, multiple classification theories, and classification methods have emerged in the history of knowledge classification, thus forming various knowledge classification methods.

In the traditional theory-oriented research of knowledge classification, the most influential is the method of Polanyi, a British philosopher's research, that is dividing it into explicit knowledge and implicit knowledge (Polanyi, 1958) based on knowledge coding and transferable perspective as first proposed in his *Knowledge*. With far-reaching impact, this classification method is widely used in subsequent research on knowledge management and technology integration and innovation (Guo, 2010). Based on Polanyi's method, the United Nations' Organisation for Economic Co-operation and Development (OECD) divides human knowledge into four categories according to the content of knowledge: know-what, know-why, know-how, and know-who (OECD, 1996). Under the practice-oriented research tradition, Holsapple and Joshi (2001) proposed a dichotomy between schematic knowledge and content knowledge, the former consisting of purpose knowledge, strategic knowledge, cultural knowledge, and basic knowledge, while the latter enveloping the participant's knowledge and knowledge artifacts. However, neither of the above two classification methods takes into account both theoretical basis and the actuality. Thus, some scholars innovatively merge the two and try to construct a multi-dimensional knowledge classification framework. Zhang and Ni (2005) proposed the octave method to highlight three dimensions: connotation, contextualization, and comprehensiveness. Since there are so many ways of knowledge classification, we don't enumerate them here. Only Table 19.2 shows the knowledge classification methods the author has sorted out based on existing literature for further discussion.

It is not difficult to find that knowledge-related issues have attracted the attention of the academic community for a long time. With the advent of the era of the knowledge economy, knowledge has gradually become the core competitiveness of various industries, which objectively promotes the development of knowledge-related research. As shown in the table above, scholars have also put forward numerous methods for knowledge classification based on different perspectives. However, the existing researches on knowledge classification are still insufficient, and the traditional dualistic thinking pattern on knowledge classification has caused insufficient understanding of the connotation of knowledge. Many scholars are trapped by the precise definition and limitation between "explicit knowledge" and "implicit knowledge", thus losing imagination of the broader connotation of knowledge and neglecting specific knowledge that features explicit and implicit factors. Most of the existing research focuses on explicit knowledge and implicit knowledge. Many of them apply knowledge as a broad concept in the research process, but only refer to the explicit part.

Table 19.2 Literature on knowledge classification

Classification basis	*Knowledge classification*	*Source or author*
Purpose of knowledge	Theoretical knowledge, practical knowledge, and creative knowledge	Aristotle
Degree of coding	• explicit knowledge and implicit knowledge • Non-coded/coded knowledge, and standardized knowledge/non-standardized knowledge • know-what, know-why, know-how, know-who	Polanyi (1958); Nelson and Winter (1982); Nonaka and Takeuchi (1995); Grant (1996); Rodgers and Clarkson (1998)Hall and Andriani (2002); Zander and Kogut (1995) OECD (1997)
Knowledge content	Employee knowledge, process knowledge, corporate memory, customer knowledge, product and service knowledge, relationship knowledge, knowledge assets, etc.	Feng (2006)
Perspective of knowledge management	• Management skills, technical know-how, marketing know-how, manufacturing and production process knowledge, and product development knowledge • Data layer knowledge, program layer knowledge, function layer knowledge, management layer knowledge, integration layer knowledge, update layer knowledge, and joint layer knowledge	Lane et al. (2001) Allee (1997)
Knowledge transfer method	Conceptual knowledge, systematic knowledge, common sense knowledge, and operation knowledge	Nonaka (2000)
Source of knowledge	Empirical knowledge and academic knowledge	Chen and Yang (2012)
Practice type	Scientific knowledge, technological knowledge, engineering knowledge	Deng and He (2007); He (2007)
Knowledge creates entity	• Individual knowledge, group knowledge, organizational knowledge, and cross-organizational knowledge • Individual knowledge, group knowledge, organizational knowledge, inter-organizational knowledge, and social knowledge	Nonaka (1994) Zhou (2006)
Epistemological perspective	• Rational knowledge, perceptual knowledge • Perceptual knowledge, rational knowledge, and active knowledge	Qian (2004); Qian and Qian (2007); Yang (2003)
Applicability	General knowledge and special knowledge	Breschi et al. (2000), Court et al. (1997)
Leading level of knowledge	Basic knowledge and professional knowledge	Lane and Lubatkin (1998)
Knowledge mobility	Static knowledge, reasoning knowledge, and dynamic knowledge	Rodgers and Clarkson (1998)
Knowledge structure	Constructional knowledge and irrelevant knowledge	Henderson and Clark (1990)
Knowledge relevance	Relevant knowledge and irrelevant knowledge	Miron-Spektor and Argote (2011)
Popularity	Local knowledge and global knowledge	Alcorta, Tomlinson and Liang (2009)
Knowledge complexity	• Deep knowledge, and shallow knowledge • Simple knowledge and complex knowledge	Rodgers and Clarkson (1998) Garud and Nayyar (1994), Bhagat et al. (2002)
Abstraction degree of knowledge	• Operational knowledge and principle knowledge • Descriptive knowledge, procedural knowledge, and causal knowledge	Rodgers and Clarkson (1998) Anderson (1995)
Inner connection of knowledge	Natural science, technology and engineering science, social and humanities	Lu Yongxiang (1998)

Source: compiled by this research.

Although the "explicit-implicit" classification method has laid the foundation for knowledge researches, it is not the only way to accurately grasp the knowledge issues in the complex management context. To break the limitation of this method at the cognitive level, it is vital to search for a knowledge concept with broader semantics and deeper extension and construct a more systematic and comprehensive thinking framework (Tu, Yang, and Yang, 2015). In recent years, some scholars (such as Spender, 1994; Zhang and Ni, 2005; Gao and Tang, 2008; Yang and Shan, 2017) have made tremendous efforts to break through the limitations of binary knowledge classification but unfortunately failed to get rid of the path dependence on binary classification.

As an essential way to acquire, accumulate, and apply knowledge, learning is closely related to knowledge. Therefore, the classification method of learning also has an important influence on the result of knowledge classification. In recent years, the basis for representative learning taxonomy can be summarized as the learning strategy and learning stage in the value chain. The latter is simply the STI/DUI learning proposed by Jensen and Johnson et al. (2004, 2007) and Lundvall et al. (2004). Because STI/DUI has built the basis for the follow-up knowledge classification method in this research, the author here makes a simple analysis of the two kinds of learning and the types of knowledge generated. Scholars have widely used the STI/DUI-related concept for a long time. In the 18th century, Adam Smith, the father of economics, pointed out two links between progress and innovation in the division of labor. One innovation is based on experience, and the other on science. The two are, respectively, connected with DUI and STI. In the late 1990s, the sixth-generation innovation model emerged that centers on knowledge and learning. Now let's straighten out the knowledge forms corresponding to STI/DUI learning proposed by Professors Jensen and Lundvall as follows (see Table 19.3).

As shown from Table 19.3, Jensen's views on the definition of the two learning modes and the types of knowledge generated are better than Lundvall, because Jenson further divides the coded knowledge into scientific knowledge and technological knowledge. However, due to the impact of the traditional dualistic thinking model, Jensen did not conduct a subdivision study of STI based on this and still combined scientific knowledge and technological knowledge into one, failing to refine the connotation of knowledge fundamentally.

Table 19.3 Knowledge types related to the STI/DUI model and the production & use

Study investigator	*STI mode*	*DUI mode*
Jensen et al. (2004)	Rooted in scientific knowledge, the main goal is to produce explicit coded knowledge	Learning that leads to the improvement of implicit abilities and the accumulation of implicit experiential knowledge
Jensen et al. (2007)	Produce and use coded scientific and technological knowledge	Experience-based learning mode in "action, use and interaction"
Lundvall et al. (2004)	Science-related learning, using the knowledge and technology of applied science as the main source of innovation	Related to experience-based "learning in action/use/interaction", and use this learning as the main source of innovation

Source: compiled by this research

A New Classification of Knowledge

Classification Basis

To improve understanding the connotation of knowledge, this chapter attempts to break the "binary" knowledge classification mindset. We take Polanyi's (1958), Nonaka and Takeuchi's (1995)'s knowledge dichotomy as the basis, and incorporate the findings of Jensen and Lundvall's research on learning and knowledge forms (Marsili, 2001; Meyer, 2002; Zheng, 2007; Chen, 2013; Chen, Zhao, and Liang, 2013). Furthermore, we draw from Zhang and Ni's (2005) multi-dimensional view on knowledge classification to combine theoretical and practical aspects. Finally, we integrate the three very similar approaches: "the stage of the value chain", "the formality or informality of the knowledge-generating activities", and "the sources of knowledge generation". Based on the learning perspective and the one-dimensional entry point of the "stage of the value chain", we classify knowledge into that generated by "pre-doing learning" (formal learning) before value creation activities and "learning by doing" (informal learning) during value creation activities based on task situations. The latter is empirical knowledge. Using "knowledge content" as the second-dimensional criterion, the knowledge generated by "pre-doing learning" (formal learning) is subdivided into scientific and technological knowledge. In the end, the "scientific knowledge-technological knowledge-experience knowledge" trichotomy is formed to grasp the connotation of knowledge more entirely and systematically and overcome the problems of existing knowledge classification methods such as dualistic thinking patterns and confusion of knowledge subdivision concepts.

Concept Definition

Out-sorting of Existing Concepts

Scientific knowledge, technological knowledge, and empirical knowledge are not newly proposed concepts. Scholars have long studied their definitions and relationships, but there has been no clear standard to integrate them. Here, the author first briefly reviews the scientific, technological, and empirical knowledge in existing materials.

From the literature on scientific knowledge, it can be found that scientific knowledge is defined in the broad sense and narrow sense. The difference between the two lies in the scope of the object described. The broad sense of scientific knowledge is oriented to the intellective system about nature, society, and thinking, reflecting objective facts and laws. In a narrow sense, scientific knowledge only refers to natural phenomena and laws, namely knowledge on natural science. Although scientific knowledge can be seen in broad and narrow senses, scholars have reached a consensus on its nature and characteristics. Specifically, they argue that it is a systematic cognitive system about natural (and social) phenomena obtained through scientific research methods, marking the reflection, explanation, and description of objective objects' attributes, laws, structures, phenomena, and essences. Technological knowledge was first attached to the scientific knowledge system. Since Layton (1974) put forward his milestone claim in the article *Technology as Knowledge* that technology is autonomous, which raised technology to a symbiotic, equal, and interactive level with science, technological knowledge has become a system independent of scientific knowledge. Now that technology is defined in broad and narrow senses, technological knowledge can also be understood in both ways. But be it broad or narrow sense, scholars generally believe that technological knowledge is about how to act, and it is the comprehensive, procedural, normative, and guiding knowledge about "what to do", "what to do with", and "how to do". It is neither a reflection of existing objective things nor inherent in the human mind. Against the premise and foundation of cognition to objective things, it transforms from the reflection of objective things to the cognition of guiding practice. Compared with scientific knowledge and technological knowledge, scholars at home and abroad have done less empirical knowledge. Based on the existing literature, it can be concluded that the complexity of experience itself not only directly leads to the relative dispersion of related research content but also makes it difficult to unify the concept of empirical knowledge. The existing definition of empirical knowledge is mainly made from the perspective of knowledge acquisition and epistemology. For example, Miron-Spektor and Argote (2011) proposed acquiring experience when the organization performs tasks from the source of acquisition. The interaction between experience and the environment ultimately creates empirical knowledge; according to Ni and Wu (2012), the empirical knowledge defined in the epistemological perspective depends on people's active participation and rational thinking. It is an individual's transformation and arrangement of experience and a blend of perceptual experience and rational knowledge.

Concept Definition under the "Scientific Knowledge-Technological Knowledge-Empirical Knowledge" Trichotomy

- Scientific knowledge

Scientific knowledge is a systematic cognition system about natural and human phenomena obtained through scientific methods. Composed of concepts, laws, theorems, formulas, and principles, it describes and understands the world. The descriptive knowledge with clear conclusions and reasons features the truth, objectivity, rationality, and universality. Concepts, judgments, and reasoning are the ways of thinking that form scientific knowledge.

- Technological knowledge

Technological knowledge is a kind embedded in a specific technical product or process, oriented to solve particular problems and achieve specific purposes. Not raised to the theoretical level, it features the procedural, normative, and instructive characteristics. It usually appears as a company of technological inventions rather than some inherent skills or inertia and manifests in operation manuals, guides, and other materialized products.

- Empirical knowledge

Empirical knowledge refers to the knowledge that is generated in a personalized concrete reality. It is organically integrated with scientific knowledge, technological knowledge, and existing relevant experience. It is processed through one's perception and understanding, feedback, and memory to fit the current situation but cannot be extrapolated to other levels yet.

The difference between scientific knowledge, technological knowledge, and empirical knowledge is shown in Table 19.4.

Table 19.4 Difference among scientific knowledge, technological knowledge, and empirical knowledge

Features	*Scientific knowledge*	*Technical knowledge*	*Empirical knowledge*
Essence	A guess or explanation of the cause of a natural phenomenon	It is developed by humans through planned and directed research to improve the effectiveness of practical activities.	It is the memory or reproduction of existing observations or experiences by humans, and a direct transformation of objective phenomena in the human mind
Main targets	Know and understand the world	Control and transform the world	Adapt and respond to the world
Object and its characteristics	The objective things existing in nature, which are not shifted by human will. It exists objectively before the subject gains scientific knowledge. Its existence precedes scientific knowledge	Artificial material things or man-made material things, namely artificial nature. Technological knowledge first, then technical practice. It can be accumulated and transferred	Personal encounters, experience, or things gone through that are created by the subject based on experience or observation, closely integrated with the specific individual, and affected by their personality
Knowledge forms	Generally appear in the form of scientific laws and propositions	Generally appear in the form of rules and instructions	Generally there is no specific form of externalization
Knowledge types	It is knowledge "we know why is so"; it is rational knowledge that can be obtained through thinking; it is universal and public knowledge	It is knowledge that solves operational problems such as "what to do" and "how to do" in the process of practice; its application is subject to time and space conditions	It is knowledge that "we know why is so", perceptual knowledge that can be obtained by the senses, and individual knowledge that is difficult to promote

The Relationship between the Three

Although the above analysis shows the differences in the essential characteristics of scientific knowledge, technological knowledge, and empirical knowledge, the three are not entirely isolated. Instead, they are independent of but interwoven with one another. Scientific knowledge and technological knowledge are like "mirror twins". Scientific knowledge guides the exploration of technological knowledge, while technological knowledge also promotes scientific knowledge (He, 2007). Scientific knowledge and empirical knowledge are inseparable. Generally speaking, scientific knowledge uses empirical knowledge as the basis and testing standards. A good deal of scientific knowledge is obtained through the processing and sublimation of the scientific spirit based on empirical knowledge. The empirical knowledge is abstracted into public and universal scientific knowledge through analysis, deduction, generalization, and other rational thinking processes. Unlike empirical knowledge to scientific knowledge, there is only one step between empirical knowledge and technology. As Aristotle said, when mankind sums up the general judgment of a class of things based on experience, technology comes into being. The evolution from technology experience is a summarizing and extrapolating process. Often without relying on any intermediary, it dramatically shortens the distance between empirical knowledge and technological knowledge. The difference between the two is that those possessing technological knowledge can easily teach others, while those with experience have difficulty imparting empirical knowledge to others. In a nutshell, each type features different connotations and attributes, but in many cases, the three can evolve to form a complete knowledge system.

Case Study

The medical industry is driven by both knowledge and information resources. Knowledge is the foundation of work and the basis for technological innovation and the formation of core competitiveness. Without sufficient knowledge as a guarantee, there is high-quality development and innovation. Integrating theories and application, clinical medicine pursues basic cognition and highlights actual application and practice. Clinicians in the front line of clinical decision-making and medical innovation are typical knowledge employees. In this part, we attempt to delve into the connotation of three types of knowledge: scientific knowledge, technological knowledge, and empirical knowledge.

Defining Basic Concepts in the Clinical Context

Since in the medical industry, the clinical context serves as the soil for the cultivation and reconstruction of heterogeneous knowledge and capabilities, and scientific knowledge and technological knowledge have significantly different roles, learning channels, and learning mechanisms. Thus, before conducting the case studies, the author gives more specific definitions of the three types of knowledge at the premise of clinical medicine.

- **Scientific knowledge** refers to the descriptive "what" and "why" knowledge about the etiology, pathology, diagnosis and treatment mechanism used by clinicians in clinical practice, scientific research, and teaching activities, consisting of concepts, laws, theorems, formulas, and principles. Specifically, it includes medical natural science knowledge, natural science knowledge closely related to medicine, and humanities and social science knowledge.

- **Technological knowledge** refers to the comprehensive, procedural, normative, and instructive knowledge of products and processes such as medical-specific artifacts and medical-specific diagnosis and treatment technologies. It is a unique knowledge system about "what to do", "what to do with", and "how to do". Specifically, it incorporates (1) User's instructions or guidelines contained in medical artifacts (such as medicines, medical equipment, and medical consumables); (2) operation instructions, procedures, rules, and guidelines contained in medical diagnosis and treatment techniques (such as physical examination techniques and auxiliary examination techniques). However, the empirical knowledge that has not been raised to a theoretical level and cannot be applied to a broader (quasi) clinical practice is excluded.
- **Empirical knowledge** refers to the strong individual and contextual knowledge about disease prevention and treatment consistent with the current clinical situation. However, it cannot be promoted yet, formed by the clinician in the (quasi) clinical practice activities by synthesizing the specific, realistic situation brought by the uniqueness and individuality of the current clinical practice itself, organically integrating scientific knowledge, technological knowledge, and existing relevant empirical knowledge and through the perception and understanding of their senses, feedback, and memory. The empirical knowledge referred to in this research is "knowledge obtained from clinical practices" by clinicians. It is a narrow concept of empirical knowledge.

Introduction to Doctor X

Basic information of Doctor X is shown in Table 19.5. Before analyzing the three types of knowledge of Doctor X, some basic information is provided. As shown in the picture above, Dr. X is 54 years old, a master's tutor, heir to the national academic experience of traditional Chinese medicine (TCM) experts, a national outstanding TCM clinical talent trainee, and a famous TCM doctor in Hangzhou. She is currently the subject leader of the national general hospital TCM work demonstration unit, the leader of the Zhejiang TCM famous department construction project, and the Hangzhou TCM-Western Medicine Integrated Oncology Division II Key Specialist, and leader of the Hangzhou General Hospital Pilot TCM Department Construction Project. She also serves as the deputy director of the Research Branch of Classical Chinese Medicine and Inheritance of Zhejiang Association of Chinese Medicine, standing member of the TCM Tumor Committee of Zhejiang Anti-Cancer Association, member of the Bone and Soft Tissue Tumor Committee of Zhejiang Anti-Cancer Association, member of the Tumor Committee of Zhejiang Association of Integrative Medicine, member of the Tumor Branch of Zhejiang Association of Traditional Chinese Medicine, member of the Department of Oncology of Anhui Medical University, a young member of the Internal Medicine Branch of Zhejiang Association of Traditional Chinese Medicine, deputy director of the Oncology Branch of Hangzhou Medical Association and the Oncology Committee of Hangzhou Society of Integrative Medicine. Dr. X has been engaged in this specialty for 23 years. She is well-trained in treating malignant tumors such as breast cancer, lung cancer, and gastric cancer with integrated Chinese and Western medicine. In particular, she has rich clinical experience in the resistance against recurrence and metastasis of malignant tumors and unique insights in treating spleen and stomach diseases such as chronic atrophic gastritis and chronic colitis.

Table 19.5 Basic information of Doctor X

	Gender	*Date of birth*	*Technical title*	*Profession*	*Educational background*
Oncologist X	Female	1967.10 October 1967	Chief TCM Physician	Tumor, spleen and stomach related diseases	Doctoral candidate

Analysis of Doctor X's Knowledge Level

Selection of Indicators

Based on the review of the existing literature, this research chooses to draw on the studies of DeCarolis and Deeds (1999), Argote and Ingram (2000), Meyer (2002), Zhang et al. (2005), and Zhao (2013) to evaluate the scientific knowledge through six indicators of "level of medical education", "scientific knowledge acquisition network", "number of relevant papers", "quality of relevant papers", "lab configuration required by basic research", and "basic research data recording"; draw on the studies of Díaz-Díaz et al. (2006), Xu and Lu (2007), Moorthy and Polley (2010), and Shawky et al. (2012) to measure the technological knowledge through eight indicators of "professional and technical titles", "technological knowledge acquisition network", "number and quality of relevant papers", "number and quality of patents", "laboratory equipment required for clinical application studies", "applied research data records"; draw on the studies of Hennart (1991), Luo and Peng (1999), Delos and Henisz (2000), and Herschel et al. (2001) to evaluate the empirical knowledge through three indicators of "years of professional work", "medical records", and "empirical knowledge acquisition network".

Knowledge Assessment

Level of Scientific Knowledge

Oncologist X graduated from Zhejiang Chinese Medical University (formerly Zhejiang University of Traditional Chinese Medicine) in July 1991, with a doctoral degree in Chinese medicine. Since 2012, she has served as a master's tutor of Chinese-Western Integrated Medicine major in the Second Clinical School of Zhejiang Chinese Medical University. Meanwhile, Dr. X also serves as the deputy director of the Research Branch of Classical Chinese Medicine and Inheritance of Zhejiang Association of Chinese Medicine and many other provincial and municipal social, academic positions. In possession of multiple academic titles, Dr. X has a relatively rich network for acquiring scientific knowledge, and the laboratory equipment required for basic research is also above average. Dr. X has always valued basic research, focusing on research design methods and research records. Since being appointed as head of the department in 2012, she devoted most of her time to department management and team building and had no time for academic papers or monographs based on preliminary research results. Only two academic papers on the fundamental research of the etiology and pathology of diseases and the diagnosis and treatment mechanisms have been published in the past five years.

Level of Technological Knowledge

In November 2007, Dr. X was promoted to the Chief TCM Physician. In addition to fundamental researches, Dr. X also pays more attention to the clinical application of diagnosis and treatment techniques and drugs. She has published 11 academic papers on clinical diagnosis and treatment techniques, drugs, and other clinical applications in the past five years, including six first-class papers. Among them, "Clinical and experimental research on Yiqi tonifying kidney oral liquid against postoperative metastasis of gastrointestinal cancer" won the third prize of Zhejiang Province Traditional Chinese Medicine Science and Technology Innovation. "Effect of Yiqi tonifying kidney formula on the invasive metastatic ability of gastric cancer cells SGD-7901" won the third prize of Zhejiang Province Traditional Chinese Medicine Science and Technology Innovation and the second prize of Hangzhou Medical and Health Science and Technology Progress Award. In 2011, the oncology department led by Dr. X has selected the second-class critical medical specialty of medical oncology in Hangzhou. With more hardware and software invested by the government and hospitals for this specialty, the current laboratory equipment can meet the demands of the application study of Dr. X.

Empirical Knowledge

Dr. X has been engaged in medicine for 23 years and has accumulated remarkable clinical experience and a personal network. In daily work, Dr. X values the quality of patients' medical records and keeps medical records in a scientific, standardized, and detailed manner. To identify new clinical issues from the clinical work, Dr. X currently attends expert oncology specialists for 1.5 days a week, and general outpatient clinics for 1.5 days, totaling more than 9,600 outpatient visits per year and 981 inpatient visits per year. Meanwhile, she participates in in-hospital consultations, the rescue of patients with intractable and critical illnesses, and various case seminars. In the past five years, she has hosted or attended an average of 323 in-hospital consultations, 12 rescues of complex and critical patients, and 16 seminars on clinical cases such as adverse events. Compared with clinical practices, Dr. X pays no attention to and rarely participates in quasi-clinical practices. However, she cares to participate in experience exchange meetings in order to gain clinical experience from peers. She attends an average of eight in-industry experience exchanges per year. Doctor X's Knowledge Level is shown in Table 19.6.

Table 19.6 Doctor X's knowledge level

Scientific knowledge	*Technical knowledge*	*Empirical knowledge*
PHD, master's tutor, extensive scientific knowledge acquisition network, medium level of laboratory equipment required for research, standardized research records, and medium to low quantity and quality of papers and monographs	Chief TCM physician, paying great attention to clinical application research, medium level quantity and quality of related papers and monographs, and the hardware and software of the laboratory basically meeting the demands of clinical application research	She has been in the medical profession for 23 years, and accumulated abundant clinical experience and personal network, with special attention paid to the quality of medical records. She undertakes more general outpatient workload and management of inpatients, mostly clinic consultation, treatment of difficult and critically ill patients, and in-hospital exchange of clinical experience. She rarely participates in quasi-clinical practice activities

Conclusion

In the era of the knowledge economy, knowledge marks the core production factor and the most precious asset. It plays a self-evident role in management. In recent years, knowledge management has become an important research field and produced many theoretical results. However, most of them have not been able to guide the development of knowledge management practice. Therefore, exploring influential knowledge management theories that integrate theory and practice is both an inevitable trend of academic research and primary demand of the development of the times. From the learning perspective, this section proposes a trichotomous knowledge classification framework of "scientific knowledge-technological knowledge-empirical knowledge". It explains it with specific cases of clinicians, hoping to improve the understanding of knowledge connotations and enhance the effectiveness of knowledge management. Knowledge classification is the foundation of knowledge management. This chapter intends to encourage more insights on this field of study, which are worthy of a more in-depth discussion in the future.

References

Alcorta, L., Tomlinson, M., and Liang, A.T. "Knowledge Generation and Innovation in Manufacturing Firms in China", *Industry Innovat*ion, Vol.16, No.3, p.435–461 (2009)

Allee, V., *The Knowledge Evolution*, Elsevier Inc. (1997)

Anderson, J., *The Architecture of Cognition*, London: Psychology Press (1995).

Argote, L., and Ingram, P., "Knowledge Transfer: a Basis for Competitive Advantage of Firms", *Organizational Behavior and Human Decision Processes*, Vol.82, No.1, p.150–169 (2000)

Bhagat, R. S., Kedia, B. L., Harveston, P. D., and Triandis, H. C., "Cultural Variations in the Cross-Border Transfer of Organizational Knowledge: An Integrative Framework", *Academy of Management Review*, Vol.27, No.3, p.204–225 (2002)

Breschi, S., Malerba, F., and Orsenigo, L., "Technological Regimes and Schumpeterian Patterns of Innovation". *The Economic Journal*, Vol.110, No.463, p.388–410 (2000)

Chen, J., The Rise of the Third Generation of Management, *Caijinjie (Guanlixuejia)*, Vol.7, p.104–105 (2013)

Chen, J., and Yang, Y. J., "The Essence of Management and the Evaluation of Management Research", *Chinese Journal of Management*, Vol.9, No.2, p.172–178 (2012)

Chen, J., Zhao, X. T., and Liang, L., "Science-based Innovation", *Science of Science and Management of S.&T.*, No.6, p.3–7 (2013)

Court, A. W., Culley, S. J., and McMahon, C. A., "The Influence of Information Technology in New Product Development: Observations of an Empirical Study of the Access of Engineering Design Information", *International Journal of Information Management*, Vol.17, No.5, p.359–375 (1997)

Decarolis, D. M., and Deeds, D. L., "The Impact of Stocks and Flows of Organizational Knowledge on Firm Performance: An Empirical Investigation of the Biotechnology Industry", *Strategic Management Journal*, Vol.20, No.10, p.953–968 (1999)

Delos, A., and Henisz, W. J., "Japanese Firm's Investment Strategies in Emerging Economics", *Academy of Management Journal*, Vol.43, No.3, p.305–323 (2000)

Deng, B., and He K., "On Scientific Knowledge, Technological Knowledge and Engineering Knowledge", *Studies in Dialectics of Nature*, No.10, p.41–46 (2007)

Díaz-Díaz, N. L., Aguiar-Díaz, I., Saá-Pérez, P. D., "Technological Knowledge Assets in Industrial Firms", *R&D Management*, Vol.36, No.2, p.189–203 (2006)

Feng, J.C., *The Theory, Technology and Application of Knowledge Management*, Beijing: Economic Press China (2006)

Gao, Z. C., and Tang, S. K., "The Analysis of Mechanism of Enterprise Knowledge-Creating Based on Cognitive Psychology", *Journal of Information*, Vol.27, No.8, p.87–91 (2008)

Garud, R., and Nayyar, P. R., "Transformative Capacity: Continual Structuring by Intertemporal Technology Transfer", *Strategic Management Journal*, Vol.15, No.5, p.365–385 (1994)

Gettier, E. L., "Is Justified True Belief Knowledge?", *Analysis*, Vol.23, No.6, p.121–123 (1963)

Grant, R. M., "Prospering in Dynamically Competitive Environments Organizational Capability as Knowledge Integration", *Organization Science*, Vol.7, No.4, p.375–387 (1996b)

Guo, A. F., Study on the Relationship Between Enterprise's STI/DUI Learning and Technological Innovation Performance, Zhejiang, Zhejiang University (2010)

Hall, R., and Andriani, P., "Managing Knowledge for Innovation", *Long Range Planning*, Vol.35, No.1, p.29–48 (2002)

He, J. S., Xiong, D. Y., and Liu H.W., "Knowledge Innovation Based on Knowledge Fermenting", *Science of Science and Management of S.&T.*, Vol.26, No.2, p.54–57 (2005)

He, K., The Comparing Research on the Scientific Knowledge, the Technical Knowledge and the Engineering Knowledge, Xi'an University of Architecture and Technology (2007)

Henderson, R. M., and Clark, K. B., "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established firms", *Administrative Science Quarterly*, Vol.35, No.1, p.9–30 (1990)

Hennart, J. F., "The Transaction Costs Theory of Joint Ventures: An Empirical Study of Japanese Subsidiaries in the United States", *Management Science*, Vol.37, No.4, p.483–497 (1991)

Herschel, R.T., Nemati, H., and Steiger, D., "Tacit to Explicit Knowledge Conversion: Knowledge Exchange Protocols "*Journal of Knowledge Management*, Vol.5, No.1,107–116 (2001)

Holsapple, C. W., and Joshi, K. D., "Organizational Knowledge Resources", *Decision Support Systems*, Vol.31, p.39–54 (2001)

Jensen, M. B., Johnson, B., Lorenz, N., et al., "Codification and Modes of Innovation", Elsinore: DRUID Summer Conference (2004).

Jensen, M. B., Johnson, B., Lorenz, N., et al., "Absorptive Capacity, Forms of Knowledge and Economic Development", *Paper Presented at the Second Globelics Conference in Beijing, 2004*, October 16–20.

Jensen, M. B., Johnson, B., Lorenz, E., et al., "Forms of Knowledge and Modes of Innovation", *Research Policy*, Vol.36, No.5, p.680–693 (2007)

Lane, P. J., and Lubatkin, M., "Relative Absorptive Capacity and Inter-Organizational Learning", *Strategic Management Journal*, Vol.19, No.5, p.461–477 (1998)

Lane, P. J., Salk, J. E., and Lyles, M. A., "Absorptive Capacity, Learning, and Performance in International Joint Ventures", *Strategic Management Journal*, Vol.22, No.12, p.1139–1161 (2001)

Layton, E. T., Jr., "Technology as Knowledge", *Technology and Culture*, Vol.15, No.1, p.31–41 (1974)

Lu, X. C., and Chen, F., "Industrial Technology in the Perspective of Knowledge Theory", *Journal of Northeastern University (Social Science)*, Vol.10, No.6, p.480–483 (2008)

Lu, Y. X., "Historical Experience and Future of Science", *Studies in the History of Natural Sciences*, Vol.17, No.3, p.197–206 (1998)

Lundvall, B. Å., Lorenz E., and Drejer, I. "How Europe's Economies Learn," *Report for the Loc Nis Policy Workshop* (2004)

Luo, Y. D., and Peng, M. W., "Learning to Compete in a Transition Economy: Experience, Environment, and Performance", *Journal of International Business Studies*, Vol.30, No.2, p.269–296 (1999)

Marsili, O., *The Anatomy and Evolution of Industries: Technological Change and Industrial Dynamics*, Cheltenham, UK, Northampton, E. Elgar (2001)

Meyer, M., "Tracing Knowledge Flows in Innovation Systems", *Scientometrics*, Vol.54, p.193–212 (2002)

Miron-Spektor, E., Argote L., "Organizational Learning: From Experience to Knowledge", *Organization Science*, Vol.22, No.5, p.1123–1137 (2011)

Moorthy, S., Polley, D. E., "Technological Knowledge Breadth and Depth: Performance Impacts", *Journal of Knowledge Management*, Vol.14, No.3, p.359–377 (2010)

Nelson, R. R., Winter, S. G., *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap Press (1982).

Ni, Q.Y., and Wu, Q. J., "Case-based Knowledge Management and Its Strategy", *Modern Educational Technology,* Vol.22, No.6, p.20–23 (2012)

Nonaka, I., "A Dynamic Theory of Organizational Knowledge Creation", *Organization Science*, Vol.5, No.1, p.14–37 (1994)

Nonaka, I. A., and Takeuchi, H. A., *The Knowledge-Creating Company: How Japanese Companies Create Dynamics of Innovation*, Oxford: Oxford University Press (1995).

OECD. The Knowledge-Based Economy. http://www.oecd.org/dataoecd/51/8,1913021

Polanyi, M., *Personal Knowledge*, London: Routledge & Kegan Paul Ltd (1958)

Qian, Z. H., "Why Are the Experimental Method and Logical Method Unusual Important to Science?", *Science Technology and Dialectics*, Vol.21, No.2, p.20–22 (2004)

Qian, Z. H., and Qian, M., "Two Sources of Technology and their Enlightenment", *Science Technology and Dialectics*, No.2, p.68–71 (2007)

Rodgers, P. A., and Clarkson, P. J., "Knowledge usage in New Product Development (NPD)," Paper Presented at IDATER 1998 Conference, Loughborough, Loughborough University (1998)

Shawky, H., Siegel, D.S., Wright, M. "Editorial — Financial and Real Effects of Alternative Investments", *Journal of Corporate Finance*, Vol.18, No.1, p.105–107 (2012)

Spender, J.-C., "Organizational Knowledge, Collective Practice and Penrose Rents," *International Business Review*, Vol.3, No.4, p.353–367 (1994)

Sveiby, K, E., *The New Organizational Wealth: Managing Measuring Knowledge-Based Assets*, San Francisco: Berrett-Koehler (1997)

Teece, D. J., "Firm organization, Industrial Structure, and Technological Innovation", *Journal of Economic Behavior Organization*, Vol.31, No.2, p.193–224 (1996)

Tu, X. Y., Yang, B. Y., and Yang, J. L., "'Ternary' Knowledge in the Complex Management Context: Problems, Epistemology and Legitimacy", *Journal of Tsinghua University (Philosophy and Social Sciences)*, Vol.30, No.1, p.166–175 (2015)

Xu, D, and Lu, J. W., "Technological Knowledge, Product Relatedness, and Parent Control: The Effect on IJV Survival", *Journal of Business Research*, Vol.60, No.11, p.1166–1176 (2007)

Yang, B.Y. and Shan, X.C., "Active Knowledge: The Activator for the Rising of Enterprises in China", *Tsinghua Business Review*, No.Z1, p.105–112 (2017)

Zander, U., and Kogut, B., "Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test", *Organization Science*, Vol.6, No.1, p.76–92 (1995)

Zhang, G., and Ni, X. D., "From Knowledge Classification to Knowledge Map: An Analysis of Organizational Reality", *Journal of Dialectics of Nature*, No.1, p.59–68 (2005)

Zhang, G. W., "Study on Innovative Classification and Characteristics of Enterprise Knowledge", *Journal of Tianjin University of Commerce*, Vol.28, No.1, p.62–67 (2008)

Zhang, S. H., and Fang, H., "A Study of the Relationship Between Organizational Climate and Tacit Knowledge Sharing in Industry Enterprises", *Psychological Science*, Vol.28, No.2, p.383–387 (2005)

Zhao, X. T., *Impact of Scientific Knowledge Resources on Innovation Performance*, Zhejiang University (2013)

Zheng, Y. Y., *Impact of Firm Science Capability*, Zhejiang University (2007)

Zhou, Y., The Innovative Mechanism and Innovative Model of Enterprises' Organization Innovation from the Angle of Knowledge, Xiangtuan University (2006)