Review and Prospect of Research on Innovation Thinking at Home and Abroad

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Abstract. Creative thinking is the core of creative ability, and the level of individual creative thinking ability is an important reflection of its creative ability. The article reviews the literature on innovative thinking at home and abroad, systematically sorts out and summarizes the concepts and characteristics of innovative thinking, summarizes the status and problems of innovative thinking research at home and abroad, and then puts forward the deficiencies of research including academic circles about innovation. The definition of the concept of thinking is not unified; there are different understandings of the characteristics of innovative thinking in the academic world; the number of innovative thinking studies is relatively small and the research direction is not clear; the macro-level research of innovative thinking training is insufficient and the countermeasures are not targeted. It also proposes future research directions for innovative thinking from strengthening theoretical research, strengthening macro- and micro-level research on innovative thinking cultivation, and strengthening scientific research activities as an important way to cultivate college students' innovative thinking, to enrich the theory and talent cultivation of innovative thinking. Important decision-making reference.

1. Introduction
Qian Xuesen once said that China has not fully developed. One important reason is that no university can run a school in accordance with the mode of cultivating scientific and technological innovation and innovative talents. Without its own unique innovations, it is always impossible to produce outstanding talents [1]. "Qian Xuesen's Question" is a difficult proposition about the development of China's education cause, which needs to be solved jointly by the entire education community and all sectors of society [2]. Qian Xuesen asked us that the key to cultivating outstanding talents is that there is no scientific model for cultivating innovative talents, so how to cultivate innovative talents and how to improve their innovation capabilities have become major issues that China's higher education needs to solve urgently. After summing up previous research results, innovative thinking is the core of innovative ability [3], and the level of individual innovative thinking ability is an important reflection of its innovative ability [4]. Therefore, researching innovative thinking is the key to improving innovation ability. This article attempts to review and sort out relevant literature on the concepts, characteristics, and current status of domestic and foreign research in academic circles at home and abroad to find out what needs to be improved and perfected in the current research, and to provide development directions for future research.
2. Research on the Concept of Creative Thinking

Regarding the definition of innovative thinking, there is currently no unified understanding in academic circles. The representative views of Chinese and foreign scholars are roughly as follows (See Table 1.):

| Criteria for scholars to define | Scholar viewpoint | Related explanations |
|---------------------------------|------------------|---------------------|
| Left brain and right brain      | The right brain thinking form | Also known as image thinking form. It is a linguistic intuition, creative imagination. |
| Follow the rules of logic or not | Non-logical thinking forms | Intuition is a form of non-logical thinking, and put intuitive thinking as the iconic, decisive link and characteristic of innovative thinking. |
|                                  | Non-logical thinking forms and logical non-logical complementary forms | The theory of divergent thinking, Tension theory, The theory of integration |
| Consciousness of thinking        | Conscious thinking forms | Such as creative imagination and development thinking |
|                                  | Non-conscious thinking forms | Such as inspiration, intuition, and epiphany. Talent say, Epiphany say |

One is based on the left brain and right brain as the standard, abstraction and image, and defines innovative thinking as the right brain thinking form. The function of the left brain mainly lies in linguistic logical thinking and inference ability; the function of the right brain mainly lies in linguistic intuition and creative imagination [4]. Therefore, innovative thinking is right-brain thinking. Both scientists, such as Einstein, and psychologists, such as Thomas R. Blackley, hold this view [5]. In their opinion, the left-brain thinking form is the abstract thinking form; the right brain thinking form is the image thinking form. However, it is one-sided to attribute innovative thinking to right-brain thinking only.

The second is to define whether to follow the rules of logic as a standard, and to define innovative thinking as non-logical thinking forms and logical non-logical complementary forms. Imagination is a form of non-logical thinking; intuition is a form of non-logical thinking. Therefore, many scholars who hold this view define innovative thinking as intuitive thinking, or put intuitive thinking as the iconic, decisive link and characteristic of innovative thinking. In view of this, many scholars advocate the definition of innovative thinking based on the unification of logical and non-logical logics, so "logical and non-logical thinking complement each other. [6] " The theory of divergent thinking holds that "innovative thinking is essentially unified with divergent thinking, and divergent thinking is the core of innovative thinking [7]." Tension theory believes that innovative thinking is the organic unity of divergent thinking and convergent thinking, and the "necessary tension" is maintained between them [8]. "The combination of convergent thinking and divergent thinking is an innovative thinking movement Basic form "[9]. The theory of integration, some scholars have integrated divergent thinking and convergent thinking, and proposed a new "expatriation thinking mode" [10]. Some scholars believe that innovative thinking is "a holistic way of thinking and an innovative way of thinking adapted to the new era" [11] [12].

Thirdly, according to the consciousness of thinking, innovative thinking is defined as conscious thinking forms, such as creative imagination and development thinking; or non-conscious thinking forms such as inspiration, intuition, and epiphany [13]. According to talent, creative thinking is a gift, a thinking activity that plays a leading role with non-logical factors or even a "mysterious force". Epiphany said that it thinks that innovative thinking is a series of non-logical thinking methods such as
inspiration, intuition, dreams, and associations, and has led to new discoveries or enlightenment under the guidance of accidental and sudden "epiphany" [14].

3. Research on the Characteristics of Creative Thinking

Guilford (1950), an advocate of modern creative research, pointed out that in the process of creative activities, innovative thinking is a concrete manifestation of individual creativity, and its core is divergent thinking. The number of ideas and assumptions that can be expressed continuously in a short period of time), flexibility (that is, the ability to think flexibly from different perspectives and directions), originality (that is, have unique ideas and original ideas) Problem-solving ideas), elaboration (that is, the specific details of things or events can be imagined and described). Yi Jinxing believes that the characteristics of innovative thinking are: the unity of seeking difference and common ground, the unity of keen intuition and the strong ability of rational thinking, thinking according to the line of dialectical logic [15]. Zhang Xiamen believes that the characteristics of innovative thinking are originality, flexibility and comprehensiveness [16]. Lin Jian believes that the characteristics of innovative thinking are seeking heterosexuality, flexibility, and openness (divergence) [17]. Hong Bo believes that the characteristics of innovative thinking are "good at asking questions from different angles and in different directions, and looking for methods and ways to solve problems; rich in imagination, daring to think, good at association, and better at using analytical analogy; there are many ideas With clear and focused goals, courageous exploration and practical verification, and the habit of looking at the unknown world [18]. Chen Xiangchun believes that the characteristics of innovative thinking are the difference of thinking modes, the initiative of thinking states, and the flexibility of thinking structures. The comprehensiveness of thinking operation, the suddenness of thinking process, the novelty of thinking expression, and the utility of thinking results; seeking difference and initiative is the basis of innovative thinking, flexible synthesis and breakthrough is the method, and novelty and utility are the purpose [19]. Li Shuwen believes that the basic characteristic of innovative thinking is originality. Originality is manifested in two aspects: one is to break the rules, not to be bound by traditional ideas and traditional ways of thinking, and good at multi-dimensional observation and multi-level analysis; foresighted, to make breakthroughs, to break through stereotypes, and to forge ahead; Good at learning from history and today's successful experience, through borrowing, adjusting angles, changing ideas, unique paths, for their own use [20]. Kang Xiaoling believes that the characteristics of innovative thinking are originality or novelty, great flexibility, artistry and non-simulation (non-logical), linkage, object potentiality, and riskiness.

4. Current status of domestic and foreign research on innovative thinking

To survive and develop, mankind must innovate. International research on innovation capabilities can be traced back more than 100 years. It is generally believed that the book "Genetic Genius", published by British physiologist Galton in 1869, is the earliest systematic scientific literature on the research of innovative ability [22]. But the innovative thinking, which is the core of the innovation ability, is applied systematically by scientific methods, much later than here. What can really be regarded as the ground-breaking research mark in this field is "The Art of Thinking" published by American psychologist Joseph Vollas in 1945, and for the first time has conducted a more in-depth study of the psychological activities involved in innovative thinking. Since then, the study of innovative thinking has increasingly attracted the attention of the psychological community. In 1945, the book "Creative Thinking" published by the famous German psychologist Wessomer, the concept of "creative thinking (innovative thinking)" was clearly put forward in the book [23]. In 1950, the American psychologist Gilford gave a famous speech entitled "Creativity" at the American Psychology Annual Conference, and started the modern era of creative research. This was also the first wave of creative research and the study of creative thinking. It has also begun to flourish. In the 1960s, American creative researchers gradually separated from the military and technical goals of the Cold War. Creative research was based on personality psychology and focused on the personality characteristics of special creators [24]. In 1967, American psychologist Gilford proposed a three-dimensional structure model
of intelligence [25]. The core of creative thinking is the divergent thinking in the second dimension of the three-dimensional structure. In the 1970s, the second wave of creative research came. Based on cognitive psychology, it focused on the internal psychological processes that caused individual creative behaviour. In the 1980s, the third wave of creative research came, supplementing the study of cognitive orientation, that is, the socio-cultural orientation, which is an interdisciplinary research orientation, focusing on creative social systems: the organization of people in social and cultural environments [26]. In 1988, Sternberg, a professor at Yale University in the United States, proposed a three-dimensional model of creativity that has a large international impact [27]. The first dimension of intelligence is closely related to creative thinking, so intelligence can also be integrated. Dimension is regarded as an innovative thinking model. In recent years, foreign creative research has presented a pattern of diversification, intermingling and coexistence of different theories and different disciplines, mainly manifested in the common pursuit of the development of human potential. There is no unified understanding of the definition of innovative thinking. At present, foreign research mainly focuses on the research of innovative thinking mechanism research, measurement, curriculum development and training in multiple disciplines, and the research of innovative thinking in specific fields. More research is overall. On the research of the cultivation of innovation ability, the research on the cultivation of innovative thinking is less and has not been fully explored and studied.

China's research on innovative thinking started relatively late. With the development of scientific research on thinking in the early 1980's, the research on innovative thinking only began to emerge. China's thinking science research was initiated by Academician Qian Xuesen. He put forward the conception of the development of Chinese thinking science and laid a solid foundation for the development of the discipline of thinking science [28]. Professor Wang Yuexin of the Chinese Society of Thinking Studies defined the nature of innovative thinking in the book "Innovative Thinking", revealing the nature of innovative thinking and the key issues of its practical application and development [29]. Professor He Shankan, a thinking science expert at Donghua University, discussed, analyzed and studied the connotation, formation mechanism, method and its relationship with inspiration and image thinking in the book "Introduction to Creative Thinking". "The relationship between innovative thinking and knowledge innovation and management, innovative thinking and technology, system, education innovation", put forward the concept of innovative thinking. [30] Professor Zhang Yisheng made an in-depth study on the nature of innovative thinking from the three aspects of the meaning of the principle of innovative thinking, the basis of the basic principle of innovative thinking, and the content of the principle of innovative thinking. On this basis, four basic principles of innovative thinking are proposed [31]. Professor Zhang Xiaomang proposed in his thesis "Logical Basis of Innovative Thinking" that "innovative thinking as a thinking process is based on logical thinking [32]. Professor Liu Kuilin in his "Innovation Genesis" "The theory of "shallow conscious inference" is proposed, and based on this theory, an "inspired generation model" is constructed, and "the rise of the science of thinking provides new motivation and opportunities to unravel the mystery of brain and inspiration. " Inspiration thinking has become the object of comprehensive research in brain science, artificial intelligence, psychology, philosophy, aesthetics and other disciplines [33]. Looking at the research on innovative thinking in China in recent years, both in terms of the quantity and quality of research results, have made great progress compared with the past, generated new views, opened up new perspectives, and deepened The original understanding, but there is no unified understanding of the definition of innovative thinking. The research mainly focuses on the theoretical discussion, training and training. There are some researches on the factors affecting creative thinking, but it focuses on qualitative research, and quantitative research is rarely.

5. Summary and outlook

5.1. Summary and evaluation of existing research
This article systematically reviews and combs the concepts, characteristics, and research status of academic circles at home and abroad, establishes links between different perspectives, and clarifies the
origin and development of research in innovative thinking. Existing research on innovative thinking presents a pattern of diversification, integration of different theories, and different disciplines, which enriches the theory of innovative thinking. The current research has the following deficiencies:

The definition of the concept of innovative thinking in academia is not uniform. There is no more unified definition of the concept of innovative thinking. Some studies confuse innovative thinking with innovative ability, which will affect the overall research direction and progress of innovative thinking. Based on literature analysis and research, this article agrees with Zhou Ruiliang's "innovative thinking is a comprehensive thinking activity that exists in multiple forms of thinking, which is new and unique, and produces new results." Summarized as divergent thinking and convergent thinking (Ashton-James & Chartrand, 2009; Chamorro-Premuzic & Reichenbacher, 2008; Colzato, Ozturk, & Hommel, 2012), the dialectical unity and mutual complementarity. It is believed that in the creative process, only the two are combined. Only when we get up can we get innovative results.

The academic circles have different understandings of the characteristics of innovative thinking. After a review of literature analysis, a more unified understanding of the academic world is the basic characteristic of originality as innovative thinking. After literature analysis and summary, this article believes that the main characteristics of innovative thinking are: breakthrough, originality, flexibility, and comprehensiveness.

The number of innovative thinking studies is relatively small, and the research direction is not clear enough. Although the research field of innovative thinking has been opened for a long time, the concept of innovative thinking is not unified, leading to the research direction has not reached an enough degree of clarity so far. Therefore, the research on innovative thinking is still blind.

Insufficient research at the macro level for the cultivation of innovative thinking, and the countermeasures are not targeted. There are many researches on the cultivation of innovative thinking, which are specific to the teaching practice of a course, but there are few researches on the overall macro level. At the same time, the failure to fully explore the internal and external factors affecting creative thinking, as well as the reasons behind it, led to a decrease in the effectiveness of the countermeasures.

5.2. Suggestions for future research directions

In view of the above analysis and conclusions, future research and innovation thinking can be further deepened and expanded from the following aspects:

Further strengthen the theoretical research on innovative thinking and scientifically define the concept of innovative thinking. Simultaneously, on this basis, we can study the evaluation of innovative thinking, formulate an evaluation index system for innovative thinking, and further study the evaluation methods.

Further strengthen the research on the macro and micro levels of the cultivation of innovative thinking, and combine qualitatively and quantitatively. The research studies the influencing factors of creative thinking, digs out the deep-seated reasons behind creative thinking, and studies the effective countermeasures of cultivating creative thinking.

Research on scientific research activities as an important way to cultivate college students' innovative thinking. Undergraduate research is often considered to be an effective way to cultivate innovative thinking [14] and improve the innovative ability of undergraduates [15] and important ways [16]. Therefore, it is necessary to strengthen the research between scientific research activities and college students' creative thinking.

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