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Developing a Competency Model for Outstanding Researchers in China

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Abstract: *Outstanding researchers are the first resource for national science and technology development, and competency is one of the important reasons affecting the performance of outstanding researchers. Currently, there is a lack of strong explanations for the competency of outstanding researchers in China. Therefore, this study uses grounded theory method to code biographies of 17 Chinese scientists layer by layer to construct the competency model for Chinese outstanding researchers. The results show that: the competency model of Chinese outstanding researchers includes five dimensions, including internal research motivation, research knowledge reserve, creative consciousness and thinking ability, research quality, research skills and self-development, and 32 competencies, including research interest, research work ambition and enterprise, etc. The model is of great significance for establishing and improving the long-term mechanism of training, selection, evaluation and professional development of outstanding researchers in China.*

Keywords: *Outstanding Researcher; Competency Model; Grounded Theory*

1. Introduction

As the first resource of national science and technology development, the quantity and quality of scientific research manpower are directly related to the level and speed of national science and technology innovation development. According to the 2018 Human Resource Power Report jointly released by the Center for China and Globalization (CCG) and The Chinese Society of Education (CSE), the average number of scientists and engineers per 100,000 population in China is lower than the world average, with 3,598 in 52 sample countries and only 1,113 in China, less than one-third. It is evident that how to develop and grow a team of outstanding scientific researchers is an important challenge for China to implement the strategic goal of a strong science and technology nation.

The overall quality of researchers is one of the important reasons that affect their research behavior and research performance, mainly in terms of their competencies. The so-called competencies are those individual potential characteristics that have a causal relationship with individual job performance, mainly including knowledge, skills, motivation, attitudes and traits [1]. In specific studies and applications, competency is expressed through a competency model [2]. Only when researchers have the competencies that match their scientific and technological work, they can become outstanding researchers and produce high scientific performance, thus making outstanding contributions to scientific and technological development.

In contrast to the importance of the competencies of researchers, the research on competencies of researchers is not yet active enough and the number of results is not much in the international and Chinese academia. Some representative results of the research in China include: Zhihao Liao[3] constructed a general quality model of innovative researchers including four elements of innovative knowledge, innovative thinking, innovative personality and innovative ability through literature research and questionnaire survey; Baolong Chen et al [4] proposed a set of competency framework for technology innovators by combining the iceberg model and existing research experience; Xiaoping Huang [5] derived a five-factor technology innovators' competency model including innovative ability-thinking style, broad and profound professional-skills, core values of scientific innovation, and propensity for academic communication and cooperation by means of qualitative interviews and quantitative analysis. By analyzing the above literature, it can be found that most of the existing studies have adopted literature research and quantitative analysis to explore the competency characteristics of researchers, and the depth of the research needs to be strengthened. At the same time, research

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specifically on the competencies of excellent researchers is rare and needs to be further supplemented. In view of this, this paper, rooted in authoritative and reliable biographies of Chinese scientists, adopts the coding approach of grounded theory to identify the key behavioral events that occurred in the academic growth of these outstanding researchers, analyze their competencies, and then form a Chinese Outstanding Researchers Competency Model (CORCM).

2. Methods

2.1 Data sources and samples

In this study, we take the biographies of Chinese scientists as the object of analysis. Scientists were chosen because we believe that they are recognized as representatives of outstanding researchers, and accordingly, they are sufficiently competent to conduct research and therefore suitable for outstanding researcher competency studies.

Table 1: Overview of the analyzed scientists.

Number	Scientist	Research field	Biography	Words
S1	Qingru Chen	Minerals processing	Yi Xue (2014).One Heart for Learning: Biography of Qingru Chen. Shanghai Jiao Tong University Press.	346,000
S2	Xuji Fan	Mechanics	Yan Meng and Zhijun Wu (2015).Aviation to serve the country and pursue dreams in the apricot field. Shanghai Jiao Tong University Press.	234,000
S3	Zehui He	Physics	Xiao Liu (2013).The rolls are open and closed at will: Biography of Zehui He. China Science and Technology Press.	290,000
S4	Shisong Huang	Meteorology	Yunfeng Chen (2015).The clouds roll in and out: Biography of Shisong Huang. China Science and Technology Press.	256,000
S5	Minhua Li	Solid mechanics	Tianxiang Mao and Baiyi Wang (2015).Green sky loyal heart: Biography of Minhua Li. China Science and Technology Press.	193,000
S6	Xingxue Li	Paleobotany	Qi He (2016).The keeper of ancient life: Biography of Xingxue Li. Shanghai Jiao Tong University Press.	265,000
S7	Zhengwu Li	Nuclear physics	Yuguang Zhu (2015). Fusion will never change: Biography of Zhengwu Li.Shanghai JiaoTong University Press.	232.000
S8	Jiankang Liu	Ichthyology	Zhao gui Qin and Tianxin Lin (2015).Green water loyal heart: Biography of Jiankang Liu. Shanghai Jiao Tong University Press.	252,000
S9	Sanqiang Qian	Nuclear physics	Nengquan Ge (2013).Atomic Dreams for the Soul: Biography of Sanqiang Qian. Shanghai Jiao Tong University Press.	432,000
S10	Shanjiong Shen	Microbial biochemistry	Weimin Xiong (2014). Aureomycin ·cowshed ·biological nitrogen fixation: Biography of Shanjiong Shen. China Science and Technology Press.	250,000
S11	Zaiyi Tian	Geology	Xiaojing Hu (2013).Look for light deep in the ground: Biography of Zaiyi Tian. China Science and Technology Press.	200,000
S12	Daheng Wang	Optics	Xiaojing Hu (2016).The Heart of China The Light of China: Biography of Daheng Wang. China Science and Technology Press.	350,000
S13	Shouwu Wang	Physics of semiconductor device	Yanping Li and Jing Kang (2015). Building dreams with silicon core: Biography of Shouwu Wang. China Science and Technology Press.	240,000
S14	Guangxian Xu	Chemistry	Qing Ye,Yanhong Huang and Jing Zhu (2013).Lifting the Weight: Biography of Guangxian Xu .China Science and Technology Press.	300,000
S15	Tongyin Yu	Polymer	Lian Duan, Jian Zhang and Wei Zhang (2016). One person and one department: Biography of Tongyin Yu.Shanghai Jiao Tong University Press.	317,000
S16	Qiaosheng Zhang	Wheat genetics and breeding	Jian Yang (2013).The wheat fields are golden in my dreams: Biography of Qiaosheng Zhang. China Science and Technology Press.	220,000
S17	Xianmo Zhu	Soil and land remediation	Jiwei Zhao and Chunjuan Zhang (2013).From red soil to loess: Biography of Xianmo Zhu. China Science and Technology Press.	230,000

The authenticity and reliability of biographies are directly related to the scientific degree of biographical analysis. The "Old Scientists' Academic Growth Data Collection Project", Officially

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launched by the Leading Group of Science and Education of China, led by the Chinese Association for Science and Technology and jointly implemented by 11 ministries and commissions, including the Ministry of Organization, the Ministry of Science and Technology and the Ministry of Education, has preserved information on the main experiences, key events and important points in the academic growth of old scientists through physical collection, audio and video recording and oral interviews, providing a complete, reliable, authoritative and systematic database of material for in-depth research on the competence of outstanding researchers.

For the selection of scientists' biographies, we followed the purposive sampling method proposed by Patton (1990) and selected those biographies of scientists that would provide the most information about the research questions [6]. We began our study with five biographies of scientists and gradually increased the number of biographies until theoretical saturation was reached. We obtained a sufficient number of codes by the time we analysed the 18th biography, at which point the model content reached theoretical saturation, and therefore the final sample size for the study was 17 scientist biographies with a total of 4.607 million words of original biographical information, the basic profile of the sample is shown in Table 1, with two female scientists and 15 male scientists among the 17 scientist biographers, from a variety of disciplines including physics, chemistry, biology, and Geology and other disciplines.

2.2 Data analysis

As mentioned in the introduction section, there is little research on researcher competency models in the field and no systematic research results have been produced yet. For this reason, our study selects the grounded theory approach, which is capable of constructing theories, as the method of constructing CORCM. Specifically, the entire biographical analysis process of scientists consists of four phases.

The first phase: Extracts of key scientific behaviors and events. In order to facilitate the coding of the information, the key behaviors and events in the scientists' research process were extracted prior to the formal coding. The process is as follows: firstly, we read through the biographies from beginning to end to get an overview of the books, so that we can have a complete impression of how the biographies were written and their specific content; secondly, we read the biographies in groups of five, looking carefully for typical behaviors and key events in the scientists' research process, and making extracts. Examples of excerpts are:

Xuji Fan said "I always ask myself this, not to have selfish thoughts, my motto is: 'Leave behind too many desires and keep your heart in balance'. My main focus is on my work, so my life my thoughts become very simple, some people ask me how much your salary is, I say I don't know, because my salary is in the card, as long as there is money in the card I get by, I wouldn't pay attention to it."

Xingxue Li's colleague and assistant for many years, researcher Xiuyuan Wu of the Palaeobotanical Office, recalled that Xingxue Li had a very good habit of keeping a diary and making records every day, no matter how busy he was, and this habit stayed with him.

After completing each group of biographies, we repeatedly pondered, analysed and evaluated the contents of this group of extracts, and returned to the original text for re-confirmation or deletion of any ambiguous contents, so as to continuously improve the angle and contents of the extracts, and to achieve the purpose of "the more extracted, the more refined". Finally, one month after each group of biographies was extracted, the biographies were re-read, and the results compared with the previous extracts to ensure that the extracts were reasonable while deepening the understanding of the scientists' academic growth.

Second phase: Initial Coding. The purpose of initial coding is to split the text and brand it to reveal the thoughts, ideas and meanings it contains [7].The unit of text splitting can be an event, an action, a sentence or even a line, etc. At this phase, our research identifies and extracts sentences from extracts of key research behaviors and events by repeatedly reading them and then naming them with a label that represents their meaning. For example, we coded "Xingxue Li 's second son, Kehong Li, recalled that he remembered Xingxue Li as always being very busy, spending almost all his time on scientific research or field work and rarely doing housework." for "busy with research all the time"; "During his university years, Xianmo Zhu was very interested in experiments and almost forgot to eat and sleep whenever he was in the laboratory, thus often violating laboratory hours for chemical analysis, experiments and the production of agricultural products." For “experimental interest”; "In his early childhood, Guangxian Xu also had an experience that gave him a method of study and research-sorting and filing-that has benefited him throughout his life, and today all his materials and photographs are sorted and kept in rows of cabinet drawers at home." For “sorting and filing”.

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Third phase: Focused coding. In this stage, we classify the labels formed by the initial coding and merge labels with similar meanings to form concepts. For example, "no days off", "working overtime" and "retiring without rest" in the initial coding reflect the scientist's active efforts in scientific work and belong to one category, which is coded as "diligence"; "history", "philosophy" and "art" reflect the scientist's knowledge structure in humanities and history and are coded as "knowledge of literature and history"; "Optimism" reflects the scientist's attitude towards scientific work and life, while "calmness" and "go easy" reflect the scientist's ability to adapt to his or her own mental state, For this reason, "optimism", "calmness" and "go easy" are jointly coded as "psychological adjustment".

Fourth phase: theoretical coding. After the concepts have been developed, the analysis of their characteristics or attributes leads to the development of further dimensions that represent the concept categories and clarify the relationships between them, thus creating the core dimensions of competence for outstanding researchers.

3. Results

During the key behavioral events excerpt phase, a total of 68,295 words of excerpted text material was obtained for this study, 600 scientists' key research behaviors and events, the number of key research behavioral events excerpted per scientist ranged from 14-58, the number of words ranged from 1091-8999, 35 key research behavioral events per person and 4017 words of text material per person, see Table 2 for details.

Table 2: Extract text data details.

Scientist	Key behavioral events	Words
Qingru Chen	46	5419
Xuji Fan	19	3462
Zehui He	36	2742
Shisong Huang	35	2554
Minhua Li	43	6524
Xingxue Li	35	6618
Zhengwu Li	30	1174
Jiankang Liu	58	4443
Sanqiang Qian	43	1091
Shanjiong Shen	22	2122
Zaiyi Tian	31	4899
Daheng Wang	49	8999
Shouwu Wang	29	4121
Guangxian Xu	26	3862
Tongyin Yu	45	2226
Qiaosheng Zhang	14	1143
Xianmo Zhu	39	6896
Total	600	68295
Average	35	4017

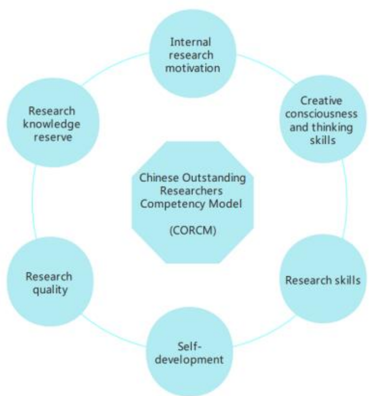

Figure 1: Chinese Outstanding Researchers Competency Model (CORCM).

The initial coding of the 600 key research behaviors and events extracted yielded a total of 72 labels corresponding to 32 concepts and six core dimensions, namely internal research motivation, research knowledge reserve, creative consciousness and thinking skills, research quality, research skills and self-development, as shown in Figure 1.

3.1 Internal research motivation

The internal research motivation dimension is defined as engaging in research for reasons of the nature of the research work itself or one's own endogenous spiritual needs. The results of the coding for key behavioral events showed that the internal research motivation dimension included a total of five concepts, which were research interest, scientific work ambition, responsibility, curiosity, and enterprise. The basic information for dimension is shown in Figure 2.

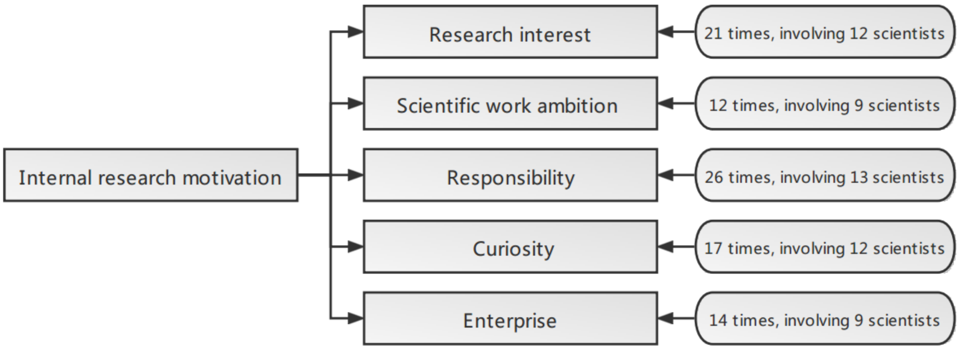

Figure 2: Internal research motivation dimension.

Sense of responsibility is the most frequent concept (26 times), and 13 scientists' biographies reflect that sense of responsibility is the main motivation for their scientific research, which contributes to the development of society and the country's prosperity through scientific research. For example, in the biography of scientist S8, it is written that "the care for the country and the people was the fundamental motivation for him. To devote himself to academic research throughout his life, and no period of time would ever dissuade him from such a strong faith. This was what he identified as the social mission of intellectuals, no matter what his beliefs were."

Research interest is second only to responsibility (21 times) in the academic biographies of scientists, some scientists are motivated by disciplinary interests, and they may have a particular preference for one or more disciplines even during their schooling, such as scientist S11 who developed a strong interest in geology as a teenager, believing that "geology is a subject that is so varied that it is worth the effort to study." At the same time, some scientists were also interested in scientific experiments; scientist S17 "was so interested in experiments that he almost forgot to eat and sleep every time he was in the laboratory, and thus often violated the laboratory hours for chemical analysis, experiments, and the production of agricultural products."

Curiosity also appears more frequently in the biographies of scientists (17 times), who are usually curious about things. Scientist S14 "showed a strong curiosity about the world when he was young. ...... As a child, he liked to pester the adults, asking how many stars there were in the sky? How many hairs do people have? ...... was also interested in the distant stars and eager to know the secrets of the stars." In order to understand the world better and satisfy their curiosity, they read a lot of books outside of school and during breaks, Scientist S9 "became addicted to books, and by the time he entered secondary school, he had read almost all the books he could read in the Kongde library".

Enterprise is one of the internal factors of scientists' excellent scientific performance, which is reflected in the academic biographies of more than half (9 of 17) , mainly in the sense that they are not satisfied with the momentary achievements and insist on seeking more effective and better solutions. As the scientist S12 said, "Don't think that we can solve the problem from all sides after such a battle, there is nothing so fast, it is impossible, because others are also progressing, you catch up with a section, and others are moving forward a section".

Most of the scientists (9 of 17) set up the ambition of engaging in scientific research since childhood, for example, the scientist S14 changed his name "to show that his ideal is not in the government, but in the scholar, in the famous scholar, and that being a pure scientist is his lifelong goal"; the scientist S11 once said "I think that studying in the Faculty of Science will lead to a path of scientific research in the future. It was a kind of nobility not to ask about politics and not to be in the

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company of the old society".

3.2 Research knowledge reserve

The research knowledge reserve dimension indicates that an outstanding researcher should have a rich and well-structured knowledge base required for research work, which includes the following five concepts: knowledge of literature and history, professional foundation, mathematical foundation, research frontier and English proficiency. The basic information for dimension is shown in Figure 3.

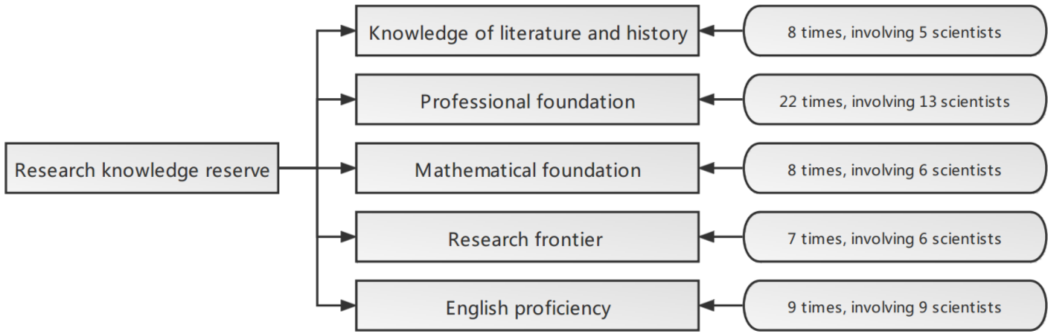

Figure 3: Research knowledge reserve dimension.

Professional foundation is the most frequent concept in this dimension (22 times), which has two main meanings: one is professional theoretical knowledge, for example, scientist S5 believes that his scientific research achievements cannot be separated from the teaching principle of Tsinghua University which focuses on basic concepts, that is, whatever content he learns, he must first figure out the basic concepts in it; the other is professional practical experience, scientific discovery relies on the accumulation of years and years, scientist S9 regards the accumulation of past work as one of the important reasons for scientific discovery.

Since scientific research often needs to refer to a large number of English materials, for this reason most scientists (9 of 17) consider English to be an important tool for scientific work, as scientist S1 once said, "English I consider to be a tool, bad English is a tool that does not work, so I require good English, I do not require to read and speak how fluent, just read and understand, fast generalization ability." Of course, the scientists themselves were also very good at English, for example, scientist S14 "always kept the habit of writing in English. His own materials, where the original text is in English, he tries to mark it in English".

Mathematical foundation refer to basic knowledge in mathematics, physics and chemistry, and scientist S4 cites a strong mathematical foundation as one of two important factors in achieving success in the field of meteorology. Some scientists demonstrated comprehension and strengths in mathematical knowledge during their schooling, when scientist S13 was pursuing his master's degree at Purdue University, his math teacher exceptionally gave him a high grade of A+ because of his particularly strong math scores.

The scientific knowledge reserve also includes knowledge of history, philosophy, art and other aspects of literature and history, which are not directly related to the content of scientific research, but help them to look at research problems more comprehensively and scientifically, scientist S6 believes that "such humanities knowledge is essential to the study of paleobotany".

Knowledge of research frontiers refers to research hotspots and trends in the field of research and its related areas. On this point, although it does not appear very often in the academic biographies of scientists (7 times), it still has commonality in six scientists. For example, scientist S15 "always paid attention to the most cutting-edge information of polymer science, and every once in a while he had to go to Fuzhou Road Foreign Language Bookstore to buy the latest specialized books".

3.3 Creative consciousness and thinking skills

Creative consciousness and thinking skills means having the awareness to break through the routine, and being good at thinking and solving problems from a super-conventional or counter-conventional perspective. The coding results showed that creative consciousness and thinking skills dimension consists of five concepts: imaginative thinking, critical thinking, analytical thinking, dialectical

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thinking, and creative consciousness. The basic information for dimension is shown in Figure 4.

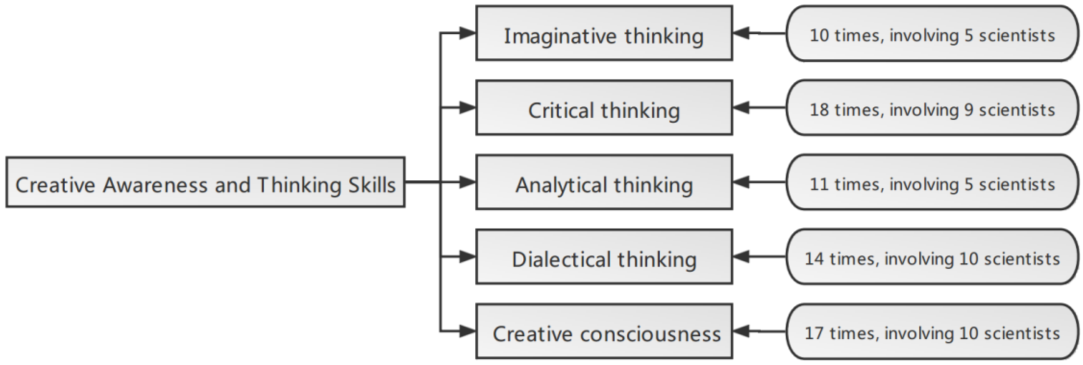

Figure 4: Creative consciousness and thinking skills dimension.

Critical thinking is the concept that appears most frequently in this dimension (18 times). Whether it is book knowledge, authoritative theories, or their own research results, scientists do not trust and follow blindly, and always keep a questioning attitude. For example, scientist S8's academic guidelines are "not to replicate without thinking", "don't be superstitious in a certain field of authoritative statements, dare to say and dare to point out the errors of authority".

Scientists generally reflect a strong consciousness of creative in their scientific work, on the one hand, they emphasize the need for creative in scientific research, such as scientist S2 put the spirit of creative a qualified scientific worker should be one of the principles and concepts: "To build a 'great product', you must need the support of creative ideas. Creative is the soul of all work." On the other hand, their own ideas are very free, such as the scientist S4, who believes that "research should not be framed, nor should ideas be framed, and it is important to think freely and do what you want".

Dialectical thinking is the ability of scientists to look at research problems flexibly, to grasp the main contradictions and to analyze them comprehensively. For example, scientist S2 believes that "in the process of scientific research, problems cannot be viewed in a one-sided and rigid manner, right and wrong are not static, but can be transformed into each other under the right conditions".

Scientists' analytical thinking is mainly manifested in clear and organized thinking when analyzing scientific problems. For example, scientist S7 said, "It is important to explain the problems one by one, not to be busy talking about another thing when one thing is not clearly explained.

Imaginative thinking is not much involved in the biographies of 17 scientists, but it is still reflected in 5 scientists. Scientific inventions cannot be created without imagination, which is an advanced form of imaginative thinking. The imaginative thinking of scientists is mainly manifested in their ability to transfer their scientific principles, methods, structures, etc., to other existing materials, processing, transformation and utilization, in order to produce new applications. For example, scientist S15 "assembled an ore radio according to the radio principle he mastered".

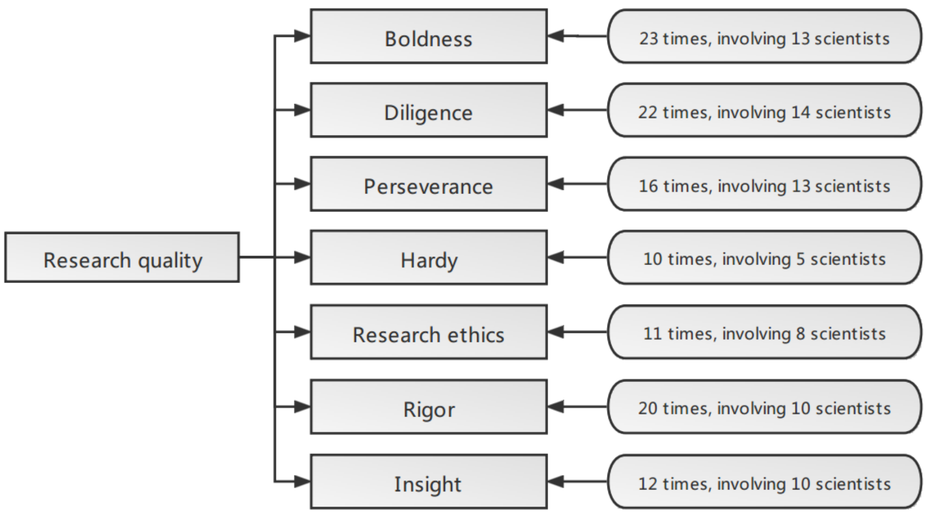

Figure 5: Research quality dimension.

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3.4 Research quality

Some good personality qualities are indispensable for efficient scientific research, including: boldness, diligence, perseverance, hardy, research ethics, rigor, and insight.The basic information for dimension is shown in Figure 5.

The most frequent indicator of this dimension (23 times) is boldness, which shows that scientists are confident in their academic abilities and are willing to accept and challenge difficult research projects. For example, scientist S1 believes that "to do a job to solve a problem, one must first be brave and dare to take responsibility".At the same time, scientific boldness is also shown in the scientist's courage to insist on the right point of view,for example, scientist S17 once worked with a Soviet expert to conduct a soil survey on the Loess Plateau. "He disagreed with the Soviet expert on the classification of Chernozem, and the Soviet expert thought that a type of soil found on the Loess Plateau at that time was Chernozem, he insisted on his view that this soil was not Chernozem at all but heilu soil from the specific environmental and geographical conditions of China."

Diligence refers to the fact that scientists usually do not have days off and work overtime to carry out scientific work, which also appears more frequently in this dimension (22 times). As scientist S9 said, "Almost all the accomplished scientists we know, both foreign and domestic, are very diligent, devoting themselves to their scientific work, even to the point of forgetting to eat and sleep in critical situations."

Most of the scientists (10 of 17) are very rigorous in their scientific work, as reflected by their great attention to research details and careful treatment of research findings. For example, scientist S5 is in the habit of keeping two copies of lecture notes and work reports throughout the year in order to double-check the content and results of the experimental reports.

Scientific research work is usually uncertain, from the beginning of scientific research to achieve the results of scientific research requires the perseverance of researchers to support, scientists in this point of consensus. For example, scientist S4 said, "Perseverance is very important, you have to get into it, you can't just touch it and give up."

Insight refers to a scientist's foresight and ability to capture the research hotspots and development directions in the field of scientific research. For example, the biography of scientist S15 mentions that he "recognized the importance of polymer physics, polymer physical chemistry and polymer technology when he founded the discipline of polymer at Fudan".At the same time, insight also manifests itself in scientists who are meticulous observers, such as the meticulous observation of scientist S3 who played an important role in her discovery of the phenomenon of triple and quadruple splitting of uranium atoms.

Research ethics is mainly reflected in the scientific research work never falsify, always adhere to the truthfulness of scientific research guidelines. For example, scientist S12 believes that truthfulness is the primary scientific thinking, and he often says that "science is an honest study that does not tolerate any sloppiness or falsity".

Field research and business trips are important components of research work in many subject areas. For example, scientist S17 participated in the comprehensive investigation of soil and water conservation in the middle Reaches of the Yellow River, which lasted for five years,the investigation covered Shanxi, Shaanxi, Gansu, Qinghai, etc. This shows that the quality of hardy is crucial to one's ability to do scientific work. As the child of scientist S5 also mentioned in the interview, she rarely complained about the environmental conditions and could adapt to almost any kind of environment.

3.5 Research skills

The successful accomplishment of scientific goals and research tasks relies on the close coordination of a number of scientific skills, the coding results on scientists' biographies indicate that these skills include:data possession,hands-on ability, teamwork, question proposes ability,and combining theory with practise.The basic information for dimension is shown in Figure 6.

Teamwork is the most frequent concept in this dimension (28 times), involving 15 scientists. Scientist S1 believes that "the individual and the group, the member and the team, no one can be separated from each other", and that "it is necessary to unite others to do things together and take advantage of the team". Scientists' teamwork skills are also reflected in interpersonal harmony, enthusiasm for mentoring and helping others, for example, Scientist S14's student commented: "Mr. Xu actually has another great strength, he is very enthusiastic about helping others".

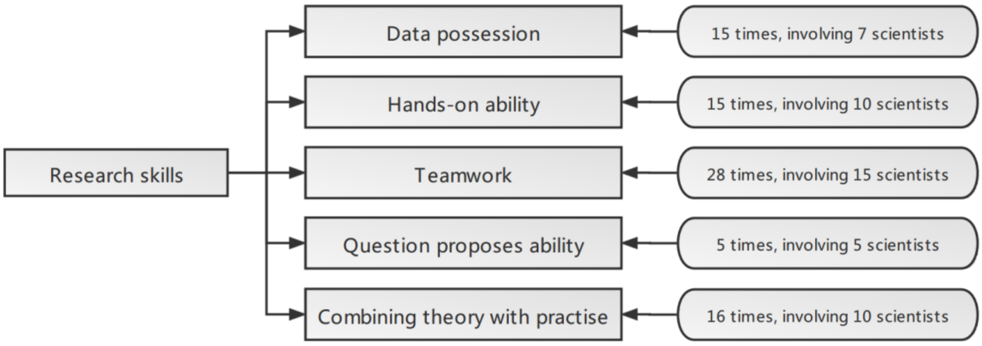

Figure 6: Research skills dimension.

Many scientists (10 of 17) summarize the ability to combine theory with practice as one of the most important reasons for success in research, for example, scientist S4 considers the combination of theory with practice to be the most important for making achievements in the meteorology profession. The combination of theory with practice in the research process is mainly reflected in the practical problem-oriented research, which means that the focus of research is on application, as scientist S4 said: "The final focus of my research is to use, it must be applied".

Hands-on ability is one of the skills necessary for scientific research work, and many biographies of scientists (10 of 17) mention that they enjoy experimenting and are very hands-on. Scientist S15's biography mentions that he was "so hands-on that he took care of almost everything in the house"; scientist S7 "put a lot of emphasis on hands-on work".

Data possession includes the ability to collect, organize and preserve data. As scientist S6 said, "detailed possession of materials is a prerequisite for any scientific innovation", scientists spend a lot of effort to collect, organize and familiarize themselves with first-hand information before achieving scientific success, and even when they talk about some of these data, they are as precious as they are, and they have also summarized some unique methods in data organization. For example, scientist S6 always makes card information of peer-related information and geological survey collection specimen information, which greatly enhances his scientific research efficiency.

The question proposes ability refers to the ability of scientists to always distill research-worthy topics. For example, scientist S5's biography states that "she knew how to distill scientific questions with long-term vitality from the practical needs of engineering", scientist S14 believes that "the correct and perceptive formulation of scientific questions is in itself a major innovation".

3.6 Self-development

Self-development means that outstanding researchers are good at adapting their own state in order to make it conducive to their research work, specifically including time management, active improvement, lifelong learning, physical adjustment and psychological adjustment 5 concepts.The basic information for dimension is shown in Figure 7.

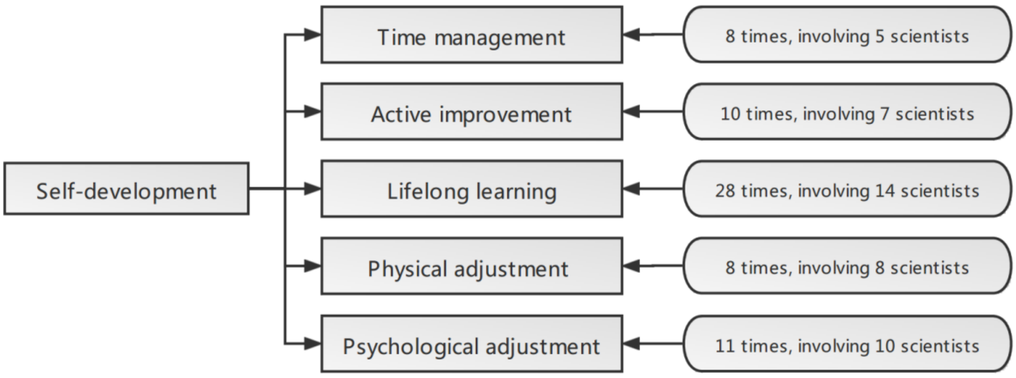

Figure 7: Self-development dimension.

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Lifelong learning is most prominent in this dimension, appearing 28 times, mainly reflecting scientists' willingness to absorb new things and learn well, as scientist S17 said, "I hope to study more phenomena in my limited life, to reveal universal and deeper patterns, and also to better solve practical problems". They indeed do so, for example, scientist S6 is still willing to learn how to use a computer from scratch at the age of nearly 85, and in less than a year, he can independently use the computer to complete his research needs.

Psychological adjustment has two meanings, one is that scientists have a optimism spirit, such as scientist S1's student, colleague and secretary for many years commented him: "In Mr. Chen's dictionary there are no two words of difficulty, and I have been in contact with him for so many years, I have never seen him worried, every time he enters the office, he is always happy"; the second is that scientists have good psychological adjustment ability, always able to deal with people and things in scientific work calmly and rationally, such as scientist S2 most often said: "I am actually still considered lucky ......".

Active improvement is targeted at the aspect of scientists' scientific work shortcomings, because many scientists have set up the ambition of scientific work since childhood, for which they have been working towards such a goal, and they are good at self-analysis, looking for their scientific work shortcomings and taking the initiative to improve themselves. For example, scientist S16 has been insisting on taking working notes and writing literature reading experience because he is not satisfied with his Chinese.

Physical adjustability refers to the ability of scientists to keep themselves physically fit to meet the demands of their scientific work through, for example, scientist S7 and scientist S8 persist in physical exercise for a long time.

Time management is mainly reflected in the scientists' strong sense of time, such as scientist S1's academic biography writes: "As long as it is the agreed time, whether it is to attend international conferences or domestic conferences and seminars, he is never late". In addition, the time management of scientists is also reflected in their time planning, as the scientist S15: "Maintaining a regular study habit for a long time, he usually wakes up at six o'clock in the morning on time, washes up and eats breakfast, reads for a while after the meal, and then goes to school to work. Go home at noon, have a good lunch, take a nap, and go to school again with his books. If there is nothing going on at school, he usually go home around 5 o'clock in the afternoon and read a book while waiting for dinner. After dinner, continue reading until about 10:30, then wash up and go to bed".

4. Discussion

This study proposes a Chinese outstanding researchers competency model (CORCM) through a grounded theoretical analysis of 17 scientists' biographies. Although the biographies of scientists selected for the study are secondary materials, it has the value of a first-hand material for the researcher. First, scientists' biographies are the actual records of scientists' academic growth, which record the key behaviors and events that occurred in scientists' scientific work and daily life, and these behaviors and events are contextual and real; second, scientists' biographies contain scientists' examination and reflection on their own behaviors and experiences, which makes the impact of key behaviors and events that occurred in the past on scientists' academic growth clearer; finally , compared with the widely used behavioral event interview method, the researcher is able to focus more on the data content selection and data analysis process, and therefore, the method is much less difficult to operate.

Through a four-phase systematic analysis, we found that CORCM consist of 32 competencies in six dimensions: internal research motivation, research knowledge reserve, creative consciousness and thinking ability, research quality, research skills and self-development. The internal research motivation is the driving factor of CORCM, which determines the goal and direction of scientific behavior and plays the role of "navigator" in the scientific work of outstanding researchers.Research knowledge reserve and research skills are the basic factors of CORCM, which are the foundation for outstanding researchers to explore the unknown based on the known.Research quality and creative consciousness and thinking ability are the facilitating factors of CORCM. Well characterization and free thinking can promote the knowledge and skill reserve of outstanding researchers as well as the improvement of research performance.Self-development is the guarantee factor of CORCM, which reflects the strict requirements of outstanding researchers for themselves and the behavioral tendency of active promotion.

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The CORCM is dominant, integrality, dynamicity, and measurability. Dominant refers to the fact that there are many categories and numbers of outstanding researcher competencies, and the CORCM only incorporates the major ones that can dominate the researcher's research behavior. Integrality means that the model is an organic coupling whole, and only through the synergistic effect of each component permeating, connecting and restricting each other, can it produce the overall effect of excellent scientific performance. Dynamicity means that the competency model is associated with a specific organization, a specific position and a specific task, that is, the competency requirements corresponding to different scientific research organizations, different scientific research positions and different scientific research tasks are different, and CORCM focuses on the common characteristics of scientific research work. Measurability refers to the fact that the competency of outstanding researchers, as a kind of psychological personality trait, can be measured and evaluated by psychological measurement, 360-degree evaluation and situational simulation.

5. Conclusion

According to competency theory, only when researchers have the competencies that match their scientific research work can they produce high research performance and thus make outstanding contributions to scientific and technological development. At present, the research on the competencies of outstanding researchers is not yet active, and the research results have some limitations. This study focuses on the composition and structure of the competencies of outstanding researchers in China to fill the gaps in existing research and to provide a reference for the training, selection, assignment and motivation of researchers in China.

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