

On the Influencing Factors of the Cultivation of Maker Talents in Higher Education Institutions

Chen Yongqiang, Yang Yang

Hangzhou Normal University, Hangzhou, Zhejiang, China

Keywords: Higher Education Institutions, Maker, Talent Cultivation, Innovation and Entrepreneurship

Abstract: Since the State Council issued the *Opinion on Deepening the Reform of Innovation and Entrepreneurship Education in Higher Education Institutions*, domestic higher education institutions have begun a new round of practice of innovative and entrepreneurial talent cultivation. How to promote the cultivation of maker talents in combination with the talent cultivation of higher education institutions has become a hotspot explored by various higher education institutions. On the basis of the researches on the cultivation of maker talents at home and abroad, combined with the typical experience of innovation and entrepreneurship in higher education institutions in China, this paper explained the requirements of basic quality and capacity structure of maker talents through such methods as expert interviews and surveys of makers, constructed the model of the influencing factors of the cultivation of maker talents, and conducted analysis on the influencing factors of the cultivation of maker talents through such methods as AHP, thus providing some reference for the scientific cultivation of maker talents.

1. Introduction

1.1 The Connotation of Makers and an Introduction of the Background

“Maker” refers to a group of people who turn their hobbies into ideas and realize the ideas, and it came from the English word “Maker”. The concept of “Enterprise Education” was first put forward in the “International Seminar of Education Orienting the 21st Century” held in November, 1989. In May, 2015, in the *Opinion on Deepening the Reform of Innovation and Entrepreneurship Education in Higher Education Institutions* it issued, the State Council pointed out that the state would comprehensively deploy the deepening of the reform of innovation and entrepreneurship education in higher education institutions. This paper focuses the cultivation of maker talents on the cultivation of innovative and entrepreneurial talents.

The Maker activity has received widespread attention in some well-known universities abroad. The Change Learning Technology Lab of Stanford University is a maker base created by MIT that offers many high-quality maker courses every year for makers around the world. Maker education developed relatively late in China, but in recent years, many universities have begun to gradually carry out innovation and entrepreneurship activities, such as the Students’ Maker Space of Tsinghua University, it’s an entrepreneurship platform autonomously established by the makers of Tsinghua University that provides the students with the space to share ideas. While improving the autonomous creation of makers, it also provides an environment for them to share their ideas. Since 2016, the Ministry of Education evaluates 50 higher education institutions nationwide with typical experience in innovation and entrepreneurship each year to promote innovation and entrepreneurship in higher education institutions.

However, the maker education in China is still in the exploratory stage, and the curriculum system, the training model and the ecology construction of maker education are not yet perfect. Based on the characteristics of maker talents, through the research on the influencing factors of maker talents, this paper analyzes the weights of influence of the knowledge, accomplishment and

capacity structure of the maker talents on their growth, thus providing some reference for the exploration of scientific cultivation of makers and the completion of the cultivation models and management mechanisms of makers in higher education institutions.

1.2 Internal Factors Influencing the Cultivation of Maker Talents

Maker talents are affected by internal and external factors during the maker activities. Internal factors are the personal qualities of maker talents, that is, their own knowledge structure, accomplishments and capacity will influence their creativity. American scholar McClelland came up with the iceberg quality model, which divides the quality characteristics of talents into invisible ones and dominant ones. Knowledge structures and skills that are easy to understand and measure are called dominant quality characteristics, and the internal factors difficult to measure such as personality and motivation are called invisible quality characteristics (1973)[1]. The dominant characteristics are often the basic qualities of the makers in maker activity. It is not easy to distinguish those who perform well from those who do not in this aspect. The invisible characteristics distinguish the makers well, but are difficult to acquire through training. The research on the dominant and invisible characteristics of maker talents is good for distinguishing between different quality characteristics and for the research on the influencing factors of the cultivation of maker talents.

1.2.1 The Dominant Quality Characteristics of Maker Talents

American psychologist J.P. Guilford put forward the theory that creative talents are composed of various basic abilities of the individuals (1950) [2]. Torrance, a psychologist of the University of Minnesota put forward the Torrance Creative Thinking Test, connecting creativity with the fluency, flexibility, originality, and precision of thinking (1974)[3]. On that basis, American scholar J. Sternberg came up with the hexagon model that affects the creativity of talents. He believed that the creativity of people is affected by six factors: creative intelligence, knowledge, innovative thinking, innovative personalities, innovative motivation and innovative environment (2006) [4]. Knowledge structures and skills are the benchmark qualities that can be most easily measured, including learning ability, innovative practical experience, and professional knowledge. Makers need to have enough knowledge and skills to continue advancing their maker activities. Relatively, having too much expertise and experience may limit the creativity of makers and hinder their innovative behaviors.

Interpersonal ability is a type of dominant quality that is easy to observe. Maker behaviors are often completed by teamwork. The communication and collaboration within the team helps with the generation of innovative behaviors. Some scholars have proved through researches that makers' interpersonal ability has a direct impact on their innovative behaviors. Makers with high-quality interpersonal relationships are more likely to have new thinking and information resources, which is conducive to promoting innovative behavior [5] (Hu Baoling, 2018).

1.2.2 The Invisible Quality Characteristics of Maker Talents

Invisible quality characteristics are a kind of quality characteristics of talents difficult to measure. They are not easily changed by external influences, but they play a key role in the behaviors and performance of people [6]. Risk is one of the basic characteristics of innovative activities. Any innovative activity will be influenced by the factor of risk. Risk factors may come from such aspects as the threats from the external environment and the complexity of the innovative projects, etc. [7] (Zhang Zhihe, 2015). That is, maker talents need to assume more risks in innovative activities. American scholars J. Sternberg and Todd Lubart came up with the theory of creative investment. Creative ideas are often opposed, from an investment perspective, this kind of behaviors increase the cost of innovation for the innovators, and the unfavorable environment adds to this psychological burden. (1996)[8]. Sunk cost is an important external factor that influences the innovative activities of makers. In innovative activities with high sunk costs, makers show significant differences in their risk tolerance in innovative behaviors (Chen Zhen, 2014) [9]. The ability of makers to take risks has become an influencing factor for maker behaviors.

Innovation originates from individuality. Individuality is in contrast to commonality. It is the personality of daring to break the traditions. Most people choose to give up innovation because of high sunk cost. Makers need to have the spirit of overcoming obstacles, breaking traditions, and challenging authority. In addition, the curiosity of continuous explorations also helps the innovation activities.

Dedication is the spirit of selfless dedication to work. This spirit not only refers to a serious and responsible attitude of work, but it also reflects the enthusiasm of employees for work and the energy they are willing to spend on work. Researches have shown that people who with lower level of focus at work tend to choose traditional ways of working, which reduces their likeliness of engaging in innovative activities. Those who love and focus on work will spend more time thinking about how to improve the efficiency in work and carry out creative activities in their fields (Ambile, 1983) [10].

1.3 External Factors Influencing Maker Talents

An external environment that can stimulate makers' innovative behaviors and promote the transformation of the innovation results is crucial for maker talents. Creating a relaxing innovation environment can stimulate the innovative behaviors of the employees, and at the same time stimulate the innovative behaviors of makers. In this environment, Makers are promoted by a subtle positive thinking to carry out innovative activities. Bandura et al named this positive thinking as "Self-efficacy" (1977) [10]. Unless people believe that they can produce the desired effect through their actions, people rarely have the motivation to act, therefore, the faith of efficacy is an important foundation of actions (A. Bandura, 2001) [11]. The self-efficacy of maker talents plays a crucial role in adjusting the relationship between the innovation environment and the innovative behaviors of makers, the innovation atmosphere of organizations can stimulate the innovative behaviors of employees through adjusting the self-efficacy of innovation (Jing Lingling, 2015)[12].

The risk of innovation is one of the main characteristics of maker activities. The risk factors differ at different stages of the maker activities, but it exists throughout the whole process. Innovation risk is a speculative risk, which can be prevented and controlled to some extent. In innovative activities, makers need to have the ability to take risks. While the external environment should, through organizational management and risk control of the innovation system, prevent and control risk losses to a certain extent, and create an innovation failure tolerance mechanism, thus providing the makers with a relatively stable external environment (Zhang Zhihe, 2015) [7].

Makers are a group of people with innovative thinking. They are happy to share and to give. However, currently, most makers in the space are limited to their own teams, and there is very little communication between project teams. This phenomenon also limits the creative development of makers. While an innovation environment that provides an mechanism of innovation and success sharing can effectively promote the sharing of the successful experience between project teams, thus promoting the generation of innovative activities (Shi Jinxiu, 2018) [13].

A good innovation environment should also provide entrepreneurial services and incentive mechanisms that makers really need. Makers need to be supported by the external environment in finance and operation, so that they can focus their energy on innovation activities, thus improving the output of innovation. Establishing a maker ecology between schools, enterprises and the government, establishing mass innovation spaces and providing makers with supports in capital, market and experience are important measures to improve the external environment of makers.

2. The Influencing Factors of the Cultivation of Maker Talents and the Weights

Through literature researches on the cultivation of maker talents, it's concluded that the influencing factors of the cultivation of maker talents are divided into external factors and internal factors. The internal factors are also called the quality characteristics of maker talents, which are further divided into dominant quality characteristics and invisible quality characteristics. In order to targeted cultivation models of maker talents, it's necessary to analyze the degrees of importance of the above influencing factors.

2.1 Research Methods

This paper adopts the method of AHP (Analytic Hierarchy Process) and provides the basis for the quantitative comparison of the weights of the influencing factors of the cultivation of maker talents through the quantitative analysis of the influencing factors. On the basis of studying the theoretical researches of experts and scholars at home and abroad, and in combination with the achievements in maker cultivation of a Top 50 institution of typical experience of innovation and entrepreneurship, namely the achievements of Hangzhou Normal University in the cultivation of innovation and entrepreneurship talents in recent years, the authors came up with the indicator system of the influencing factors of the cultivation of makers. Through interviews with experts and surveys among makers, the impacts of each level of indicators in the indicator system on the target layer were compared, and the weights of different influencing factors on the cultivation of maker talents were obtained through the analytic hierarchy process.

2.2 Constructing the Hierarchical Model

This paper came up with the hierarchical structure model based on the literature review and the principle of the analytic hierarchy process, as shown in Figure 1. The factors that influence the cultivation of maker talents are divided into six first-level indicators: interpersonal communication, knowledge structure and skills, innovation environment, innovative way of thinking, innovative personalities and dedication. And sixteen second-level indicators were determined, respectively team communication skills, expertise and mechanism of innovation incentives, etc.

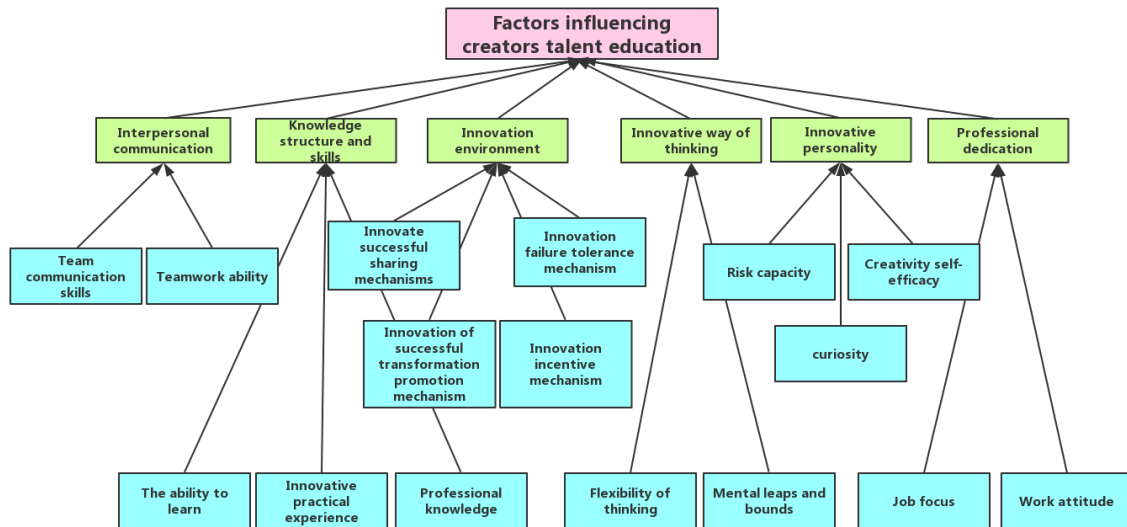


Figure 1 The factor chromatography structure model of creators talent cultivation

2.3 The Determination of the Weights of Various Levels of Indicators

This paper adopted the method of questionnaires, and invited industrial experts of different fields such as cultivators of makers in higher education institutions, successful entrepreneurs and responsible people of mass innovation spaces to assign points for the degrees of importance of the influencing factors of the cultivation of makers. By comparing the relevant index factors layer by layer, the importance of each pair of indicators was compared and judged, thus establishing a judgment matrix; Consistency checking was conducted by calculating the maximum eigenvalue of the judgment matrix and the corresponding eigenvector [14]. The second-level judgment matrix and impact weights are as shown in Table 1. While due to limitation of the length of the paper, the third-level judgement matrix and impact weights are not enumerated here.

Table 1 The consistency ratio of influencing factors in the creators talent cultivation: 0.0680;The weight of influencing factors on maker talent cultivation: 1.0000; λ max: 6.4287

Factors Influencing Creators Talent Education	Interpersonal Communication	Knowledge Structure and Skills	Innovation Environment	Innovative Way of Thinking	Innovative Personality	Professional Dedication	Wi
Interpersonal Communication	1.0000	0.3333	0.3333	0.1667	1.0000	2.0000	0.0847
Knowledge Structure and Skills	3.0000	1.0000	1.0000	0.2500	1.0000	3.0000	0.1543
Innovation Environment	3.0000	1.0000	1.0000	0.2000	1.0000	1.0000	0.1227
Innovative Way of Thinking	6.0000	4.0000	5.0000	1.0000	4.0000	3.0000	0.4411
Innovative Personality	1.0000	1.0000	1.0000	0.2500	1.0000	2.0000	0.1174
Professional Dedication	0.5000	0.3333	1.0000	0.3333	0.5000	1.0000	0.0798

It's found through the checking that the maximum eigenvalue of the matrix of Table 1 was 6.4286, with a consistency ratio (CR) of 0.0680<0.1, the consistency ratios of other comparison matrix were all smaller than 0.1, and they all passed the consistency checking. The weights of the degrees of influence of indicators in all layers were got at last, as shown in Fig. 2.

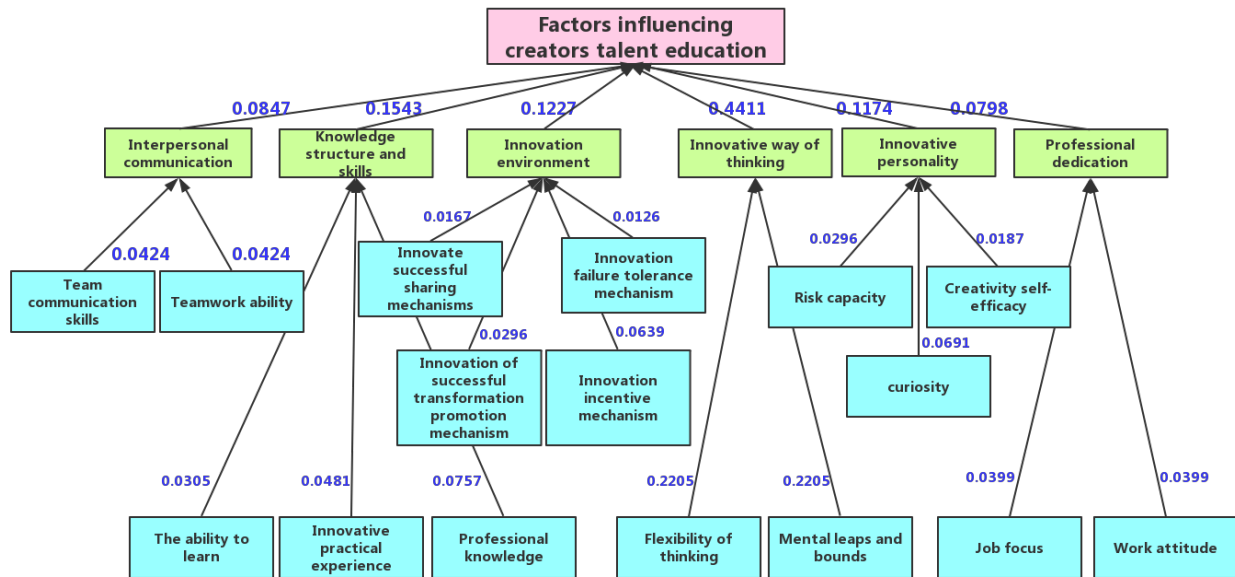


Figure 2 The weight of factors influencing the creators talents cultivation

3. Conclusions and Inspirations

3.1 Conclusions

Through AHP analysis, the weights of the degrees of importance of the elements in various layers to the decision target were got, as shown in Fig. 2. The following conclusions can be drawn through analyzing the results:

3.1.1 The Degrees of Influence of Different Factors to the Cultivation of Makers

The degrees of the influence of factors on the cultivation of maker talents are, from the largest to the smallest, innovative ways thinking, knowledge structure and skills, innovative environment, innovative personalities, interpersonal skills and dedication, etc. The most important factor influencing the cultivation of maker talents is the innovative ways of thinking, which has a great relationship with the innate factors of the makers; knowledge structure, skills and innovative environment are at the second level. Thus it can be seen that acquired learning and a good environment for innovation and entrepreneurship are very important for the cultivation of makers; while innovative personalities, interpersonal skills and dedication are at the third level.

3.1.2 The Influencing Factors of the Knowledge Structure and Skills of Makers

It can be found from the results of analysis that the accumulation of professional knowledge, experience of innovative practice and learning capacity all have great influence on the improvement of the knowledge structure and skills, in which a solid foundation of professional knowledge and the practical experience of innovation have great influence on the cultivation of makers, and the learning capacity also plays an important role in the acquiring of new knowledge and mastering of new skills of the makers.

3.1.3 The Influencing Factors of Innovative Environment

The innovative environment has a great influence on the result of maker activities, and in the four dimensions of the creation of innovative environment, the most important ones are the mechanism of innovation incentives and the mechanism of transformation of achievements, this is inseparable from the fact that start-up teams need more supports and external resources in the earlier stage. In addition, the mechanisms of success sharing and failure tolerance also play a supportive role in the creation of the ecological environment of makers and the alleviation of the pressure of makers, therefore, they also have some degree of influence on the creation of the innovative environment.

3.1.4 The Influencing Factors of Innovative Personalities

It's found in the research that innovative personalities, as an invisible quality characteristic of makers, also has an obvious influence on the cultivation of maker talents, in innovative personalities, curiosity has the greatest influence on the cultivation of makers, followed by the ability of taking risks and the self-efficacy of creativity.

3.1.5 The Influencing Factors of Interpersonal Skills

The factor of interpersonal skills is in the third level of the degrees of influence on the cultivation of maker talents, and through judging the interpersonal skills from the dimensions of team communication skills and teamwork skills, it's found that the two of them have equal influences on interpersonal communication. Therefore, proper team practice in the process of innovation and entrepreneurship is of great significance to the improvement of the interpersonal skills of makers.

3.1.6 Influencing Factors of Dedication

Dedication was measured in two dimensions, focus on work and working attitude, and it's found in the research that the two of them are equally important to the growth of makers, but dedication is the dominant quality that has the least influence on the cultivation of makers.

3.2 Inspirations and Suggestions

In view of the above analysis and conclusions, the cultivation of maker talents can be carried out in two aspects, the dominant qualities and the invisible qualities, and at the same time strengthening the creation of innovative environment of makers, thus promoting the cultivation of makers. With the cultivation of maker talents of information technology as the example, the authors put forwards some suggestions on the cultivation of maker talents in higher education institutions.

3.2.1 Promoting the Cultivation of Maker Talents Through Phased Implementation

Knowledge structure and skills are the dominant factors restricting the development of maker talents. Knowledge structure and skills can be improved by designing tasks and goals of different stages. For example, the implementation method of “four stages” can be adopted for undergraduate students. Firstly, for the stage of skill reserve of junior grade, curriculum systems that suit the cultivation of innovation and entrepreneurship talents can be designed, standards of capacity of different majors can be formulated, and skill assessments can be organized each year, and all students can be required to reach the standards to enter the next stage;

3.2.2 Laying Emphasis on the Creation of the Ecological Environment of Maker Activities

The environment of maker activities is an important influencing factor in the cultivation of makers, so, schools should lay emphasis on the construction of the environment of maker activities, the construction can be strengthened from the perspective of the creation of ecological environment of innovation. The first is to strengthen the construction of carriers of maker activities, for example, IT enterprises and industrial parks can be introduced to construct incubation bases, mass innovation spaces and industry-university-research bases together with the school, thus providing carriers for the activities of makers through providing mutual benefit mechanisms for enterprises in customized talent cultivation and project development and guaranteeing the operation of the co-constructed bases. The second is to strengthen the soft environment construction of the maker bases. The soft environment construction of maker bases includes internal mechanisms of management and operation, local supportive policies, incentive mechanisms, entrepreneurial culture, etc. including introducing the local government's support for innovation and entrepreneurship, introducing the guidance funds of surrounding enterprises or parks, establishing a team of students as a public service platform to provide business services to the entrepreneurial teams, introduce platforms of the transformation of the innovation incubation results and reforming the evaluation mechanisms for teachers and students, etc. thus providing a good ecological environment of innovation and entrepreneurship for the makers through the construction of software and hardware environments.

3.2.3 Deepening the Reform of Education and Promoting the Transformation of the Talent Cultivation Model

The foothold of the above two aspects of work is the reform of the talent cultivation models of higher education institutions. The reform of the talent cultivation models is a systematic project. It is necessary to combine the concept of talent cultivation in new engineering disciplines to realize the matching and effectiveness of talent cultivation through reform so as to improve the ability of talent cultivation. First of all, the cooperative education mechanism of cooperation between schools, government and enterprises must be introduced. From the perspective of creating the ecological environment of makers, a collaborative education mechanism led by the government, dominated by the school and participated by enterprises should be established so that the cultivation of maker talents in higher education institutions can closely meet the needs of industrial development. The second is to improve the talent cultivation program. On the one hand, higher education institutions should combine the characteristics of maker talent cultivation, modify and improve the talent cultivation program, embed part of the innovative and entrepreneurial courses in the talent cultivation program, so as to improve the knowledge structure of maker talents; On the other hand, higher education institutions should improve the design and arrangement of the practice of talent cultivation, such as ensuring the credits and hours for skill testing and participating in project development, thus encouraging students to actively participate in the practice of innovation and entrepreneurship. The third is to strengthen the reform of classroom teaching. The purpose of the reform of the talent cultivation model is to improve the quality of talent cultivation, and classroom teaching is the main battle field of this. Schools should actively introduce new teaching methods such as maker education, flip classrooms, micro-lessons and MOOC, implement process evaluation, change the teaching model dominated by teaching into the exploration-oriented learning model dominated by the active thinking of the students, continuously improve the effect of teaching and

cultivate the innovative spirit of the students so as to improve the effectiveness of the cultivation of maker talents through the reform of classroom teaching, the improvement of the talent cultivation program and the introduction of the mechanism of collaborative education, etc.

Acknowledgements

Financially aided by the Collaborative Education Program of the Ministry of Education (201701015116) and the Higher Education Reform Program of Hangzhou Normal University: Constructing and Practicing the Cultivation System of Maker Talents Oriented by the Demand of the Grand Corridor of Scientific Innovation of the West of the City.

References

- [1] David C.McClelland. Testing for Competency Rather Than Intelligence [J]. American Psychologist, 1973.
- [2] Guilford, J.P.Creativity [J].American Psychologist, 1950.
- [3] E.P.Torrance.Torrance Tests of Creative Thinking [J].Scholastic Testing Service, 1974.
- [4] Sternberg,R.J.The Nature of Creativity[J].Creativity Research Journal,2006.HU.
- [5] Bao-ling.The Influence of Teacher-Student Relationship and Classmate Relation on Postgraduates' Creativity: The Mediating Effect of Role Identity [J].Journal of Jimei University, 2018.
- [6] RONG Jie. The Analysis of the Mismatch of Employees and Positions in Enterprises' Recruitment and the Solutions [J].OJournal of Heze University, 2011.
- [7] Zhang Zhihe, Xu Ke, Li Peng. An analysis on the delayed effect of innovation input and the cause of innovative risks [J].Science Research Management.2015.
- [8] Robert J Sternberg, Todd Lubart. Investing in Creativity [J].American Psychologist.1996.
- [9] CHEN Zhen, WANG Xue. Innovation, Sunk Cost and Firm Survival: An Empirical Analysis Using China's Micro-Level Data [J].SCIENCE OF SCIENCE AND MANAGEMENT OF S. & T.2014.
- [10] Amabile, T. M.The social psychology of creativity [J].NewYork:Springer.1983.
- [11] Bandura, A .Social learning theory [J].Englewood Cliffs.NJ: Prentice Hall.1977.
- [12] Bandura, A. Social cognitive theory: An agentic perspective [J]. Annual Review Psychology.2001.
- [13] Jing Lingling, Jiang Huan. The influence of university innovation culture on Postgraduates' innovation behavior: The moderating effect of innovation self-efficacy [J].Academic Degrees & Graduate Education. 2015.
- [14] SHI Jinxiu. Research on the Impact of Environment for Creativity and Entrepreneurship in Innovation Spaces on the Makers' Behavior [J]. JOURNAL OF WUXI INSTITUTE OF TECHNOLOGY.2018.
- [15] ZOU Tao, SHI Yun. The Application of AHP in the Design of Children Bicycle [J].PACKAGING ENGINEERING.2019.