DEVELOPING THE CONSTRUCT OF STUDENT DEVELOPMENT USING FUZZY DELPHI TECHNIQUE: A STUDY ON THE UNDERGRADUATES FROM VOCATIONAL UNIVERSITIES IN SHANDONG, CHINA

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By

XING QIAONA

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ABSTRACT

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Xing Qiaona

The main research content of this thesis is to develop the student development construct of China's undergraduate vocational universities and improve the quality of training high-quality tech talents in China. This thesis adheres to the problem-oriented approach and conducts four-stage research to solve the core problems of irrational talent construct, low training quality, and insufficient talent quantity in response to the existing issues in training high-quality tech talents in China.

This thesis is based on undergraduate vocational education, student development theory, and expert opinions. Specifically, it designed the student development construct based on the implementation process of OBE theory. This thesis is a four-stage study: In the first stage, the researcher analyzed the necessity of student construct design by interviewing vocational education policymakers, undergraduate vocational university talent training goal makers, and students. At stage two, this thesis used the Fuzzy Delphi Technique (FDT)

and Analytic Hierarchy Process (AHP) to design the undergraduate vocational education student development construct. In the third stage, evaluated the student development level. This thesis developed a student development instrument and evaluated student development level. At stage four, proposed countermeasures to improve student development level based on the differences between the evaluation results and student development outcomes.

The research methods of this thesis include interviews, FDT, AHP, and questionnaire methods. The FDT was used to design the student development construct indexes, and the AHP was used to assign index weights. A stratified sampling method was used to select 1422 students from three undergraduate vocational universities in Shandong, China. This thesis designed a student development instrument and used the questionnaire to collect student development data. The SPSS (version 25) software was used to test the reliability and validity of the questionnaire and to analyze the collected student development questionnaire data to evaluate the student development level.

The research value of this thesis includes: First, using Outcome-Based Education (OBE) theory in Chinese vocational education and student development will enrich the research results of student development theory and Chinese vocational education. Second, this thesis helps solve the problem of the shortage of high-quality tech talents in China and helps Chinese

undergraduate vocational universities to improve the quality of student training. Third, this thesis is based on the OBE of student development quality, which provides new ideas for reforming China's education quality evaluation.

Keywords: Undergraduate vocational education, Student development, Fuzzy Delphi Technique, Analytic Hierarchy Process, OBE theory

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APPROVAL SHEET

This dissertation/thesis entitled "**DEVELOPING THE CONSTRUCT OF STUDENT DEVELOPMENT USING FUZZY DELPHI TECHNIQUE: A STUDY ON THE UNDERGRADUATE FROM VOCATIONAL UNIVERSITIES IN SHANDONG, CHINA**" was prepared by XING QIAONA and submitted as partial fulfillment of the requirements for the degree of Doctor of Philosophy (Social Science) at Universiti Tunku Abdul Rahman.

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Date: 15 February 2024

SUBMISSION OF THESIS

It is hereby certified that **XING QIAONA** (ID No: **21AAD00364**) has completed this thesis entitled "DEVELOPING THE CONSTRUCT OF STUDENT DEVELOPMENT USING FUZZY DELPHI TECHNIQUE: A STUDY ON THE UNDERGRADUATE FROM VOCATIONAL UNIVERSITIES IN SHANDONG, CHINA" under the supervision of Assistant Professor Dr. Tan Huey Pyng (Supervisor) from the Department of Journalism, Faculty of Arts and Social Science, and Assistant Professor Dr. Gan Sun Wan (Co-Supervisor) from the Department of Psychology, Faculty of Arts and Social Science.

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Xing Qiaona

(Xing Qiaona)

DECLARATION

I hereby declare that the dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

Name: Xing Qiaona

Date: 15 February 2024

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
CCSS	China College Student Survey
CSDI	College Students Development Index
CSEQ	College Student Experiences Questionnaire
FDT	Fuzzy Delphi Technique
MOE	Ministry of Education of the People's Republic of China
NSSE	National Survey of Student Engagement

CHAPTER 1

INTRODUCTION

1.1 Research Background

School education in China has two classification methods: level and type. The Higher Education Law of the People's Republic of China (1999) divides the country's education into five levels, which are preschool, elementary, primary, secondary, and higher education (Figure 1.1). Secondary education is divided into two classes: elementary and advanced secondary. Higher education is divided into three levels: college, undergraduate and postgraduate. Chinese school education is divided into regular education and vocational education according to its type. Apart from that, there are two types of secondary schools in China, which are regular and vocational. Similarly, higher education is divided into regular and vocational types too. Furthermore, regular higher education is divided into three levels - college, undergraduate, and postgraduate levels. Meanwhile, higher vocational education, on the other hand, consists of college and undergraduate vocations (Figure 1.2). (Section 1.5 of this chapter will give specific explanations on related terms)

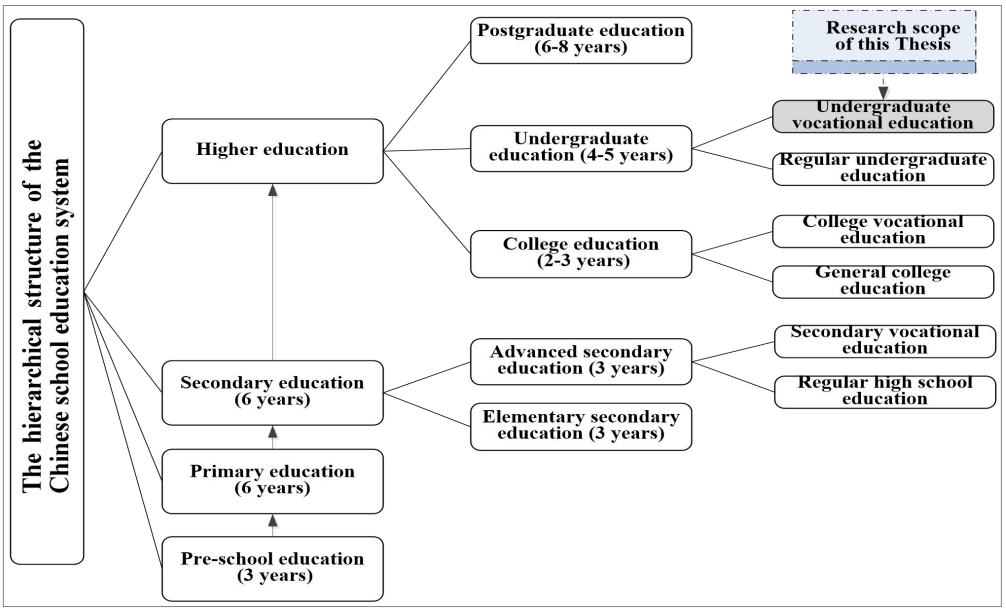

Figure 1.1: Hierarchical Structure of China's School Education System

Source: Design of this thesis

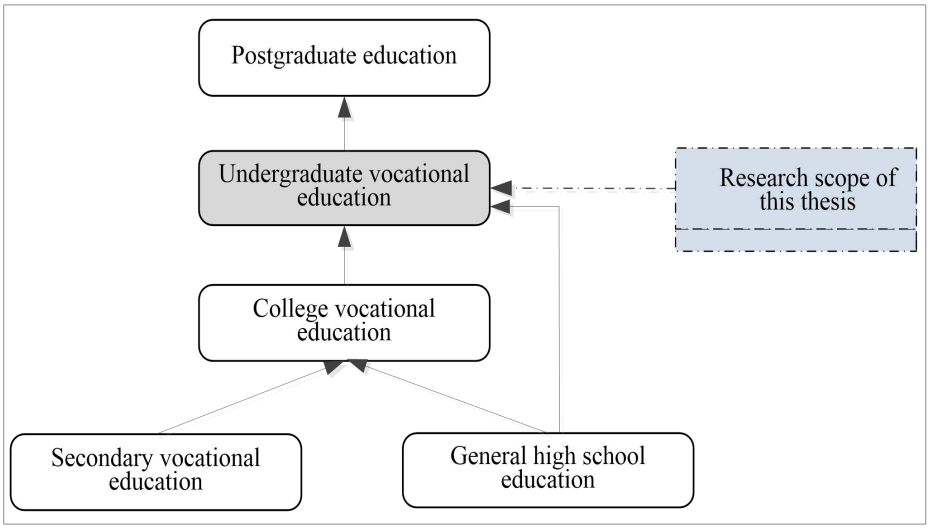

Figure 1.2: Sources and Levels of Higher Vocational Education in China

Source: Design of this thesis

Higher vocational education is an integral part of Chinese school education. The State Council of China (2019) issued the National Vocational

Education Reform Implementation Plan, which pointed out that high vocational education and regular high education are different types of higher education, and they are equally important (The State Council of China, 2019). According to data from the Ministry of Education of China, there were 1,423 higher vocational colleges in China in 2019 (Ministry of Education, 2019). By the end of 2021, the number of people receiving general higher education and higher vocational education in China has reached a ratio of 1:0.85.

Two critical social phenomena contributed to the development of undergraduate vocational education in China. First of all, China's higher education has moved from "elitist education" to "universal education" (MOE, 2019). Higher education was named elitist before 2002 due to its high standard and international recognition. Only particularly outstanding Chinese students could receive higher education. Hence, secondary school leavers' enrolment into higher education in China was always low and was in the first range, with a rate below 15%.

Nevertheless, in 2002, the status of Chinese higher education changed from elitist to popular as the enrolment rate exceeded 15% for the first time, making its way into the second popular range: 15% - 50%. In 2019, the enrolment rate of higher education in China exceeded 50%, which marked China's higher education entering the universal education stage (MOE,2019).

It can be seen that the enrolment rate in higher education in China is gradually increasing, and more and more young Chinese people can enter colleges and universities. Before May 2019, higher vocational education was only at the college level. Hence, most young Chinese people who could reach the undergraduate admission score chose to further their studies at universities that offer regular undergraduate education. However, Chinese youth who do not get the undergraduate admission score would prefer a regular or vocational college.

Another phenomenon that led to educational change is social and economic development requires more high-quality tech talents. China's economy is developing rapidly, and traditional industries must innovate technology and increase production capacity. The development of science and technology has brought more emerging industries, such as cloud computing, the internet of things, big data, artificial intelligence, 5G, etc. These emerging industries have put forward higher requirements for the knowledge and abilities of technical talents. Therefore, China needs a group of talents with solid basic theory, strong practical ability, application ability, transfer ability, and creative ability to meet the needs of social and economic development. However, the existing regular universities and vocational colleges training graduates can no longer meet their needs (MOE, 2019). Therefore, China needs to establish vocational universities to meet this demand.

Table 1.1: List of Vocational Pilot Universities in China

Serial Number	University Name	Province	Approval time
1	Quanzhou Vocational and Technical University	Fujian	2019
2	Nanchang Vocational University	Jiangxi	2019
3	Jiangxi University of Software Professional Technology	Jiangxi	2019
4	Shandong Vocational and Technical University of	Shandong	2019
5	Shandong University Engineering and Technology	Shandong	2019
6	Shandong University of Foreign Affairs	Shandong	2019
7	Henan Vocational University of Science and Technology	Henan	2019
8	Guangdong Business and Technology University	Guangdong	2019
9	Guangzhou Vocational and Technical University of Science and Technology	Guangdong	2019
10	Guangxi City Vocational University	Guangxi	2019
11	Hainan University of Science and Technology	Henan	2019
12	Chongqing Vocational and Technical University of	Chongqing	2019
13	Chengdu Vocational University of the Arts	Sichuan	2019
14	Xi'an Vocational University of Information	Shaanxi	2019
15	Xi'an Vocational University of Automobile	Shaanxi	2019
16	Liaoning Vocational University of Technology	Liaoning	2020
17	Yuncheng Vocational and Technical University	Shanxi	2020
18	Zhejiang GuangxiaVocational and Technical University of Construction	Zhejiang	2020
19	Nanjing Vocational of Industry Technology	Jiangsu	2020
20	Xinjiang Tianshan Vocational and Technical University	Xinjiang	2020
21	Shanghai Zhongqiao Vocational and Technical University	Shanghai	2020
22	Hunan Software Vocational Institute	Henan	2021
23	Jingdezhen Vocational University the Arts	Jiangxi	2021
24	Shanxi Vocational University of Engineering and	Shanxi	2021
25	Hebei University of Industry and Technology	Hebei	2021
26	Hebei Vocational and Technical University of Science and Engineering	Hebei	2021
27	Hebei Petroleum University of Technology	Hebei	2021
28	Guangxi Vocational University of Agriculture	Guangxi	2021
29	Lanzhou Petrochemical University of Vocational	Gansu	2021
30	Lanzhou Resources & Environment Voc-Tech University	Gansu	2021
31	Guiyang Healthcare Vocational University	Guizhou	2021
32	Zhejiang Pharmaceutical University	Zhejiang	2021

Source: MOE (2021)

The government needs to evaluate the training quality of vocational universities. In May 2019, the MOE approved upgrading 15 vocational colleges to hold vocational pilot universities to solve the problem of vacancies in demand for high-quality tech talents. It is the beginning of undergraduate

vocational education in China. Up to now, China has established 32 vocational universities (Table 1.1). As undergraduate vocational universities were established for a short period, China's national education authority is still figuring out and creating a stage to design a suitable student development construct that would train and generate high-quality and competent graduates. Therefore, this requires vocational education scholars to solve three problems. Firstly, they need to know what specific requirements China's economy and society have for high-quality tech talents. Besides, they need to evaluate the student development level of vocational universities. Thirdly, they should implement practical countermeasures for student development in vocational universities (Meng & Xu, 2020). In response to the above problems, this thesis developed the construct and evaluated the student development level of vocational universities and then put forward countermeasures for student development. The Outcome-Based Education (OBE) theory is a theory that emphasizes outcomes. It focuses on designing learning outcomes before implementing measures and evaluating learning results. Learning outcomes are the guidance and reference for taking education and teaching actions and evaluating learning results. OBE theory aligns with the status quo of vocational universities in China. If these universities want to assess and improve the student development level, they must be guided by student development outcomes. Therefore, this thesis followed the implementation process of OBE theory and first designed the student development construct (development

outcomes). Then, it evaluated the student development level and put forward suggestions for student development.

1.2 Problem Statement

The shortage of high-quality tech talents in China is reflected in two aspects. First, China's total number of them is insufficient. In 2018, the Chinese Academy of Social Sciences released the "China Talent Development Report". According to its data, among the 774 million employed population in China (Employed population refers to the people who are 16 years old and above, engaged in specific social labor or business activities and obtain labor remuneration or business income), only 47.91 million high-quality tech talents accounted for 6.2% of the total employed population in China. In 2020, China's high-quality tech talent gap reached 20 million people (Chen, 2020). Second, the structure of China's high-quality tech talents is unbalanced. In 2017, the Ministry of Education of China, the Ministry of Human Resources and Social Security, and the Ministry of Industry and Information Technology jointly issued the "Manufacturing Talent Development Planning Guide," which pointed out that by 2025, the high-quality tech talent gap in ten fields such as new generation information technology, new materials, and electronic equipment will further increase (MOE, 2016). In April 2019, Vice Premier of the State Council of China, Sun Chunlan, pointed out at the National Conference on Deepening Vocational Education Reform that China's economy

is undergoing a critical transformation and upgrading. Various industries need high-quality tech talents, incredibly advanced manufacturing, and modern service industries (MOE, 2019).

The graduates trained by existing regular universities and vocational colleges can no longer meet high-quality tech talent needs (MOE, 2019). China urgently needs many high-quality tech talents, but the current training quality and speed in China are lacking. On the one hand, the talents trained by the existing regular universities do not meet the needs of high-quality tech talents. On the other hand, the training of talents in vocational colleges is separated from the requirements of enterprises and society, and the level of graduates they train is not high (Meng & Xu, 2020). It requires higher vocational education to pay close attention to the student development level, accelerate reform and development, further connect with the market, and effectively support the high-quality development of China's economy (Xi, 2019). Therefore, to meet the economic and social development requirements for high-quality tech talents, China has proposed the construction of vocational universities. The vital task of the existing vocational universities is improving student development and training high-quality tech talents. It is the key to solving the current gap in China's high-quality tech talents.

The development path of vocational universities and the orientation is not

clear. The enrolment rate of higher vocational education in China is constantly increasing, achieved in two ways (Meng & Xu, 2020). The first way is to transform the existing regular colleges and universities into vocational colleges and universities to train more tech-quality tech talents. Currently, this transformation is still in progress. The other way is to upgrade original vocational colleges to vocational universities and expand the enrolment scale to achieve the rapid development goal of higher vocational education. China's vocational education development model differs from the European and American countries, some of which usually develop vocational education by adding specialized vocational colleges or community colleges (Xu & Lu, 2020). Therefore, China's vocational universities have not fundamentally changed their university positioning, training goals, development paths, and training effects. Graduates trained by these universities can hardly meet the requirements of China's social development. Besides, undergraduate vocational universities have just started in China. Their development has few references and is still exploratory, so their orientation is unclear (Xu & Lu, 2020).

The student development goals of vocational universities are unclear and under-researched (Meng, 2020). In the early stage of the development of Chinese vocational universities, it is necessary to make a scientific and reasonable plan for them and clarify their development orientation, to ensure that they move forward steadily and reliably in the correct direction. Therefore,

at this stage, scholars need to formulate undergraduate vocational university talent training goals and specifications following social and economic development needs for high-quality tech talents. At the same time, they need to clarify the various ability indexes of student development and evaluate the actual level of student development. It can point out the direction for these universities to implement and improve talent training and student development. There is much research on the training goal of undergraduate vocational education, but there is almost no research on the specific goal and indexes of student development (Meng, 2020). Therefore, this thesis aims to design the student development construct and evaluate the actual level of student development for vocational universities to fill the research gap. Finally, this thesis puts forward requirements for improving student development.

Shandong Province attaches great importance to the development of vocational education and is a model for modernizing China's vocational education. In January 2020, the National Vocational Education Innovation Development Highland launching ceremony jointly established by the Ministry of Education and Shandong Province was held in Jinan, Shandong. The MOE issued "The Opinions of the Ministry of Education and the People's Government of Shandong Province on Promoting the Improvement of Quality and Training and Building a Highland for Innovation and Development of Vocational Education", which pointed out that Shandong Province needed to

play a leading role in promoting vocational education pilot universities to continuously improve the talent training level and school running, and accumulate reproducible and extendable experience for the further development of vocational universities (MOE, 2020). Therefore, this thesis takes students from all three vocational universities in Shandong Province as the research subjects.

1.3 Research Objectives

The overall research goal of this thesis is to clarify the construct and level of student development in undergraduate vocational universities in China and to provide a reference for undergraduate vocational universities to improve the student development level. Specifically, this thesis aims to achieve four objectives corresponding to the four research phases one-to-one.

1. To determine the necessity of student development construct design from a practical level. (Stage 1)
2. To design the indexes required by the student development construct according to expert opinions and the implementation process of OBE theory. (Stage 2)
3. To evaluate the development index level of the overall and different groups of vocational university students (Chapter 4 for details). (Stage 3)

4. To propose countermeasures to improve the undergraduate vocational university student development level. (Stage 4)

1.4 Research Questions

This thesis mainly has four research questions.

1. Is it necessary to design an undergraduate vocational university student development construct? (Stage 1)
2. What are the indexes required for the undergraduate vocational university student development construct according to experts' opinions? (Stage 2)
3. What is the development index level of overall and different groups of students in undergraduate vocational universities? (Stage 3)
4. How to improve the development level of undergraduate vocational university students? (Stage 4)

1.5 Operational Definition

To better understand the content of this thesis, this section explains the nine core concepts in detail.

a. Higher education

According to the Education Law of the People's Republic of China, higher education refers to schooling implemented based on completing

advanced secondary education (National People's Congress, 1995). This thesis is referred to vocational education conducted based on completing secondary education, and it is the primary social activity for training senior specialized talents and vocational staff.

b. Vocational education

The definition of vocational education has two definition methods: broad and narrow sense. The vocational education defined in the book *Vocational Pedagogy* edited by Liu and Xu (2002) illustrates the difference between vocational education in a broad and narrow sense. It points out that vocational education broadly refers to all educational activities that enhance people's vocational knowledge and skills, train people's vocational attitudes, and help them successfully engage in a particular vocation. However, that in the narrow sense refers to purposeful, planned, and organized educational activities carried out by schools for students. It can help students acquire specific vocational knowledge, skills, and attitudes and help students prepare for a particular career. In this thesis, vocational education is in a narrow sense. It refers to a purposeful, planned, and organized educational activity carried out by vocational schools for students to guide them to acquire specific vocational knowledge, skills, and attitudes and help them prepare for a particular career.

c. Higher vocational education

Encyclopedia of Chinese Education points out: Higher vocational education is an education for training advanced practical and applied talents and is a part of higher education. At the same time, it is also a higher level of vocational education, recruiting graduates from secondary vocational schools, regular high schools, and intermediate skilled workers with corresponding cultural and practical experience. These students receive 2-3 years (4-5 years if necessary) of education in a junior college or vocational university. The education process focuses on training students' practical skills and helping them become senior applied talents and technical workers required by the social production sector (Zhang, 1991). The higher vocational education in this thesis aims to train practical and skilled talents with specific theoretical knowledge and strong practical ability. Their employment direction is the grassroots and the front line of production, service, and management. It is the advanced stage of vocational and technical education. The focus of this thesis is undergraduate vocational education in higher vocational education.

d. Undergraduate vocational education

Different scholars have different definitions of undergraduate vocational education. Ma (2015) believes it aims to cultivate high-level technical application talents. Vocational universities improve students' vocational skills and overall quality through planned and organized training so that students can

obtain corresponding qualification certificates when they graduate. Fang (2019) believes it is an education for training high-quality tech talents with solid technical theory, technical application, and preliminary research capabilities. They may face the front-line production, construction, management, and service job groups. In this thesis, undergraduate vocational education refers to training high-quality tech talents with specific professional technical theories, solid practical ability, technical application ability, transfer ability, and creative ability. They could face front-line production, construction, management, and service job groups.

e. Outcome-Based Education (OBE)

In 1981, American scholar Spady put forward OBE theory for the first time. It is an educational theory oriented by students' learning outcomes (Spady, 1994). The learning outcomes pointed out here do not refer to the student's academic performance but the student's ability to do the job after the end of the learning process. OBE theory focuses on the behavioral results of students after learning and what jobs or tasks they can perform, and it emphasizes the measurement of student behavioral results. Therefore, OBE is also called education based on learning output. At the same time, it attaches great importance to evaluating learning results, which has become a standard for verifying the effectiveness of education. In the OBE theory, before the school implements teaching, it should clarify the learning outcomes and let

them decide on other educational processes. OBE pays attention to the high matching of course content, course implementation, effect evaluation, and learning outcomes. OBE theory aligns with the status quo of student development in China's vocational universities in the early establishment stage. Therefore, this thesis uses the reverse design principle of OBE to design the student development construct, which is the concretization of student development outcomes.

f. Student development

Student development refers to the various aspects of growth we expect students to obtain after university studies. Foreign scholars believe it mainly includes knowledge, ability, value, attitude, interpersonal relationship, cognitive learning, moral and emotional development, etc. (Astin, 1993; Bowen, 1978; Chickering, 1993). Chinese scholars believe that it mainly includes two aspects: cognitive and non-cognitive development. Specifically, it mainly comprises knowledge, ability, value, morality, interpersonal communication, cognitive thinking ability, organizational ability, expression ability, psychological quality, and emotional development, etc. (He, 2019; Guo, 2014; Pan, 2019; Wang, 2014; Zha, 2017; Zhou et al., 2011). In summary, in this thesis, student development refers to the cognitive and non-cognitive development students obtain during university, specifically knowledge, ability, value, and quality (Figure 1.3).

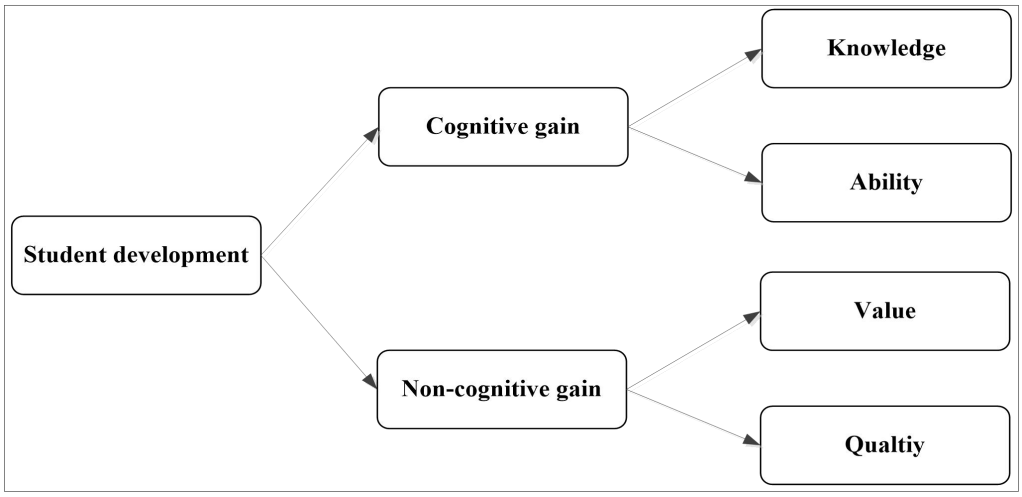

Figure 1.3: Student Development Theoretical Model

Source: Design of this thesis

The student development construct in this thesis is the concretization of the student development outcomes. It is a collection of student development indexes decomposed layer by layer according to the logical construct of the student development theory (Detail explanation in Chapter 4.). The student development in this thesis refers to the development of college and university students.

g. College Student Development Index

The College Students Development Index (CSDI) is used to evaluate student development level and their results after studying. The size of the index reflects its evaluation result. CSDI is used to express the student development level as a whole or in the dimensions of knowledge, ability, value, and quality development. It is a relative number constructed by exponential calculation

representing the student development level (Yang & He, 2018). The index is a value between 0 and 1, and the size of the index indicates the student development level. The closer it is to 1, the higher the development level. On the contrary, the more intimate it is to 0, the lower the development level.

h. Fuzzy Delphi Technique (FDT)

Dalkey and Helmer proposed the Delphi method in 1960, a form of group opinion or decision making obtained by consulting experts. It is an anonymous way for experts to put their views and suggestions on the indexes system in the questionnaire without meeting or discussing. Then, the researchers repeatedly consult, summarize, and improve the expert opinions making them more unified (Zhong, 2019). The Fuzzy theory aims to solve the ambiguity in the natural environment. Its outstanding advantage is based on the human problem-solving thinking mode. It can realistically describe the logical thinking that imitates humans, and it is in the Fuzzy measurement of complex things and systems. It reflects human experience based on recognition, reasoning, control, and decision-making (Ma, 2012).

Murray, Pipino, and Gigch first proposed using fuzzy mathematical theory to overcome the shortcomings of the traditional Delphi method in 1985, known as the Fuzzy Delphi Technique (FDT). Its basic principle is to transform the subjective judgments of the expert group into objective data. It uses Fuzzy

triangular numbers to replace semantic variables to evaluate indexes. Applying the FDT for index selection shortens the survey time, comprehensively considers the uncertainty and ambiguity of experts' subjective thinking, and effectively evaluates the research indexes (Ishikawa & Amagasa, 1993).

i. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) was first formally proposed in the mid-1970s by American operations researcher Saaty, a multi-objective decision analysis method that combines qualitative and quantitative analysis methods (Kumar, 2017). It mainly involves decomposing an objective into multiple sub-objectives, subdivided into some indexes. Authoritative experts familiar with the research content are invited to rank each level index based on their rich personal knowledge and working experience and to compare and judge the importance degree between every two indexes to score them. The researcher builds a judgment matrix based on the scoring and calculates its maximum eigenvalues and the corresponding eigenvectors to obtain the weight of the importance degree of different indexes, which can provide a basis for the optimal solution (Vaidya, 2006).

1.6 Research Significance

The significance of this thesis is divided into two parts: theoretical and practical importance.

The theoretical significance of this thesis includes two aspects. First, this thesis could enrich the results of Chinese student development theory. Chinese scholars' research on student development is mainly drawn from Western countries, and the types of empirical studies are single and not rich in research content (Zha, 2016). In particular, no representative research on student development in undergraduate vocational universities has yet emerged. This thesis begins with the design of learning outcomes concerning OBE theory and starts with a new student development construct, which enriches student development theories in China.

Furthermore, this thesis is a new result of theoretical research on Chinese vocational education. This thesis drew on related theories such as undergraduate vocational education and student development, designed the construct of undergraduate vocational education student development level, and evaluated the student development level. The results of this thesis could promote the theoretical research of Chinese vocational education, which is a new application of the OBE theory in the field of Chinese vocational education and a new result of the academic research of Chinese vocational education.

The practical significance of this thesis includes four aspects. Initially, this thesis promotes the better development of vocational university students in China. The research subjects of this thesis are students from vocational

universities, and it focuses on the student development of vocational universities. The development construct proposed in this thesis is based on the perspective of students' development, which not only meets the requirements of high-quality tech talents for social and economic development but also meets the needs of students for their development. Therefore, this thesis could help student development in Chinese vocational universities. After that, this thesis offers a guideline for the student development of vocational universities in China. These universities started relatively late, and there are very few. Currently, there is no reference for developing vocational universities in China. In particular, there is no uniform, high-quality student development template, and the education department has not yet evaluated and tested the student development level. This thesis not only designed the student development construct of vocational universities and quantitatively assessed the student development level but also put forward suggestions for improving student development, which could provide a guideline for student development in vocational universities. Then, this thesis can give insight into China's education reform. Currently, Chinese education authorities mainly evaluate the quality of education from the perspective of education investment and rarely assess it from the perspective of student development outcomes. However, the proposed construct of student development based on the OBE of this thesis pays more attention to student development outcomes. This change in the evaluation perspective can help China's education evaluation reform broaden

its horizons.

Moreover, the results of this thesis can contribute to China's alleviation of the shortage of high-quality tech talents. This thesis proposes that the student development construct and countermeasures to improve the student development level can better clarify the talent training goal and development direction for undergraduate vocational universities and point out the path for them to improve the student development level. It will help these universities train more high-quality tech talents that China urgently needs in economic transformation, industrial upgrading, and technological innovation, thereby alleviating the talent shortage in China.

1.7 Chapter Summary

The needs for social and economic development are the driving force for developing China's vocational universities. In the process of economic transformation, industrial upgrading, and technological innovation in China, various industries have higher and higher requirements for knowledge and skills talents. Therefore, China's economic and social development needs more high-quality tech talents. However, the existing Chinese higher education colleges and universities have insufficient ability and low quality in training high-quality tech talents, which requires China to establish more vocational universities to increase their number.

Solving the bottleneck of the development of vocational universities is an essential goal of this thesis. China is vigorously developing vocational universities to solve the enormous gap in high-quality tech talent. Pilot universities for undergraduate vocational education should establish more scientific student training programs, which need to be based on the current development level of vocational universities and needs to meet the quality requirements of talents. At the same time, vocational universities need to establish a system for assessing the quality of student development, use evaluation results to improve training programs, and accumulate more schooling-running experience to accelerate vocational universities' development. Therefore, this thesis is guided by the talent demand of China's social and economic development, designs a scientific and targeted student development construct, objectively evaluates the student development level, and puts forward countermeasures to improve the student development level. It points out the direction for improving the quality of talent training for Chinese undergraduate vocational universities. It realizes the healthy development of students and universities, which is also the most significant value of this thesis.

CHAPTER 2

LITERATURE REVIEW

This thesis studies student development in undergraduate vocational education based on OBE theory. The literature review detailed previous research on undergraduate vocational education, student development, and OBE theory, summarized and outlined the research gaps, and composed the theoretical basis and rationale for this thesis.

2.1 Undergraduate Vocational Education

2.1.1 Development of Undergraduate Vocational Education

In the second half of the 20th century, Europe began to develop undergraduate vocational education. The development of vocational education in Europe is divided into three stages. They are the vocational tendency of early higher education and undergraduate vocational education's rise and differentiation.

Stage One: the vocational tendency of early higher education. It originated in medieval European universities. Many courses offered by higher education institutions in the Middle Ages were vocational; some are known

today as “business courses” (Rudy, 1984). The development of social industrialization prompted the emergence of specialized colleges or technical colleges in Western countries. For example, École des Ponts Paris Tech (1747), German Mining Institute (1766), Rensselaer Polytechnic Institute in the United States (1824), and so on. These institutes aim to train senior technical management talents with a certain vocational education tendency. However, in a strict sense, they are not vocational education, and their courses are mainly theoretical sciences.

In addition, city universities had emerged in England, such as Faith College in Sheffield (1874) and University College in Nottingham (1881), etc. There were some differences between these cities and traditional universities. City Universities mainly offer science and technology courses and train practical talents for local industry and commerce. However, traditional universities and educators at that time rejected the vocational tendency of higher education. In the 19th century, the rationalism of “abandoning the practicality and professionalism of education” finally occupied the dominant position of Western higher education thought (Wu, 1989). Later, many of the technical colleges mentioned above were gradually upgraded to universities, and they turned to theoretical teaching and research. To sum up, just as some scholars believe that “higher education is not inherently insulated from vocational education; it has gone through a turn before it is separated from

vocational education" (Zang, 2014).

Stage Two: the rise of undergraduate vocational education. Contemporary undergraduate vocational education emerged in the second half of the 20th century. There are two reasons for its promotion. One reason is that higher education is affected by social performance and needs to meet social and economic needs. After the end of World War II, Western countries quickly invested in social and economic recovery and reconstruction, and they needed many high-quality professional and technical talents. In the 1960s, the development of human capital theory promoted the development of social performance. Governments of various countries attach great importance to social performance results. Therefore, governments worldwide paid more attention to education investment and believed education should serve the national economy and the employment of members of society. Higher education should perform not only academic responsibilities but also bear the responsibility of directly benefiting society and training talents (Taylor et al., 2008). Another reason is that higher education was gradually becoming popular and universal, and higher education needed to respond to the diverse needs of students. According to statistics, from 1940 to 1999, the world's average gross enrolment rate in higher education rose from 1.3% to 18.32%, and that in developed countries rose from 2.9% to 56.13% (Bie & Yi, 2018). The purpose of many students for higher education is not for basic but applied

knowledge. Kerr (2001) believes including popular and universal higher education students in the elite framework is a substantial historical mistake. Therefore, in many Western countries, undergraduate vocational education has developed rapidly. The most common practice is establishing specialized higher vocational education institutions (Table 2.1). In 1970, a "vocational education movement" emerged in America. Many traditional universities, even liberal arts colleges, have added vocational departments to provide students with vocational education (Huang, 2008).

Table 2.1: Representative Institutions of Undergraduate Vocational Education in European Countries in the Second Half of the 20th Century

Country	Institution name	Formation time
United Kingdom	Polytechnic	1966
France	University Institutes of Technology	1966
Ireland	Institutes of Technology	1970
Germany	University of Applied Sciences	1971
Sweden	University College	1977
Portugal	Polytechnic Institute	1977
Greece	Technological Educational Institute	1983
Netherlands	University College	1987
Finland	Polytechnic	1992
Austria	University of Applied Sciences	1993
Norway	University College	1994
Switzerland	University of Applied Sciences	1995

Source: Guan (2021)

Stage Three: the differentiation of undergraduate vocational education. After the 1990s, the development of undergraduate vocational education in Western countries has become more complicated. Its primary manifestation is the phenomenon of "academic drift" in the development of vocational

education, and it presented a “snake-shaped” development. Most countries, such as Finland, Austria, and Switzerland, still vigorously developed specialized higher vocational education institutions in this period. However, there has been an “academic drift” in higher vocational education in some countries. For example, in 1992, all polytechnic colleges in the UK were upgraded to universities, and the university’s vocational education attributes weakened (Xu & Lu, 2020). The “academic drift” phenomenon has also appeared in undergraduate vocational education in some other countries (Huang & Guan, 2021). For example, in 1998, Germany agreed to a unified English translation of “Fachhoc Hschulen” from the University of Applied Sciences (Feng, 2010). Although there is an “academic drift” phenomenon, undergraduate vocational education is not gradually weakening. As early as 1956, Riesman pointed out the “snakelike procession” phenomenon of higher education, which refers to a ranking of higher education institutions and lower-status institutions imitating higher-status higher education institutions. At the same time, new institutions were constantly emerging to replace the status of more subordinate institutions (Feng et al., 2022). Therefore, there always were new educational institutions or forms to fill the vacancy of undergraduate vocational education.

For example, the predecessor of the German University of Applied Sciences is a technical college. With the development of the college, the

academic research function of colleges has been continuously strengthened, and they have gradually divorced from vocational education. But also Germany has produced a new kind of higher vocational education institution-Duale, Hochschulen. Its predecessor was the vocational college, whose training model was apprentice training. Initially, society did not recognize this college as a higher education institution. Still, in 2002 it was granted the right to confer a degree, and in 2009 it was upgraded to a Duale Hochschulen. It is regarded as a supplement to the German University of Applied Sciences, where “academic drift” has occurred. Germany, Italy, the United Kingdom, the United States, Australia, and other countries have also seen the penetration of vocational apprenticeship colleges into higher education (Guan, 2019). Work-based apprenticeship vocational colleges have more characteristics of vocational education than school-based vocational education. In this sense, the development of higher apprenticeship has injected vitality into the development of undergraduate vocational education and has helped undergraduate vocational education have more vocational characteristics.

In summary, it can be seen that different countries are affected differently by the degree of socio-economic and technological development, and their undergraduate vocational education implementation institutions and development methods are also various.

2.1.2 Research Necessity of Undergraduate Vocational Education Development

In the late 1990s, China began to explore undergraduate vocational education. Scholars focused on the social function of undergraduate vocational education. The main research results are that the development of undergraduate vocational education can meet the talent needs of social development, improve the modern vocational education system, and meet the development needs of the educated.

The development of undergraduate vocational education can meet the talent needs of social development. The strategic adjustment of China's economic structure has changed the production methods of Chinese enterprises. Labor-intensive is transformed into technology-intensive. The number of high-tech positions continues to increase, and companies have put higher requirements on technical personnel's knowledge, ability, and overall quality. (Liu, 2016; Que et al., 2019; Shen & Zhu, 2023). In this context, the demand in the labor market has changed from quantity to quality, and enterprises' requirements for the technical personnel's job abilities have also been continuously improved, leading to a severe shortage of high-quality tech talents in China. The talent demand gap and the shift in labor market demand urgently need to be resolved. College vocational education can no longer meet the needs of society. It is an inevitable trend for China's higher vocational education to extend to a higher level, and vigorously developing undergraduate

vocational education is an unavoidable requirement to solve this problem (Li, 2012).

The development of undergraduate vocational education can improve the modern vocational education system. In developing China's vocational education for more than 40 years, China's vocational education system is imperfect. The college has always been the "ceiling" of vocational education qualifications. The lack of undergraduate education and above has caused an imbalance in the structure of the education system, which is not conducive to the development of higher vocational education. China proposes that the development of undergraduate vocational education can also improve China's modern vocational education system (Ma, 2014). Vocational education is a type of higher education that should be the same as regular higher education. Higher vocational education should include three levels: college, undergraduate, and postgraduate. For a long time, China's higher vocational education has been limited to the college level, and there has been a gap in undergraduate vocational education. (Wang & Wang, 2014; Xia, 2007; Xu, 2012). Scholars have proposed different ways to improve the level of higher education. However, it is generally believed that the rapid development of higher vocational education can be realized only by enhancing the level of higher vocational education. Liu (2001) proposed that local regular undergraduate and provincial undergraduate universities can organize four-year undergraduate

vocational education and build a multi-level higher vocational education system. Xiao (2012) suggested that China's vocational education should be aligned with general education, which should play the essential role of secondary vocational education and the leading role of higher vocational education. Higher vocational education should add undergraduate vocational education and explore professional degree graduate education, which can make higher vocational education form a pyramid-shaped vocational education hierarchy. Xu (2012) proposed that China needs to actively develop undergraduate vocational education and change the status quo of the highest specialist degree for vocational education students. It can enhance the cohesion and attractiveness of vocational education and optimize the hierarchical structure of the modern vocational education system.

The development of undergraduate vocational education can meet the needs of the educated to achieve their self-development. It is an urgent need for vocational education students and an important method to solve the current "difficulty in employment" of higher vocational education students in China. Chinese scholars generally believe that vocational education students have difficulty finding jobs. They have studied the reasons for employment difficulties and proposed a solution to this problem. There are two main reasons why it is difficult for it.

On the one hand, society's requirements for the quality of talent in higher vocational education continue to increase, and it is difficult for students in vocational colleges to meet the needs of enterprises for talent. On the other hand, the popularization of higher education in China has accelerated, and the number of college graduates has increased rapidly. The social phenomenon of "difficulty in obtaining employment" is becoming more and more intense (Liang et al., 2010). The solution proposed by scholars is that China needs to develop undergraduate vocational education and open up a pathway for college vocational education students (Guo & Xu, 2017). They are eager to improve their academic and technical level by upgrading from college to undergraduate (Guo & Wang, 2015). Therefore, China has developed undergraduate vocational education to open the pathway for vocational college students. It can provide them with a higher level of vocational education qualifications. Also, it can meet society's demand for high-quality tech talents and promote the further development of educated individual capabilities (Meng & Xu, 2020).

In summary, developing undergraduate vocational education in China is an inevitable requirement for social development.

2.1.3 Specifications of Undergraduate Vocational Education Talent Training

This section sorts out the literature on characteristics and specifications of undergraduate vocational education talent training to enhance the researcher's explanations on the positioning of that.

Table 2.2: Differences between Undergraduate and College Vocational Education

Project		College vocational education	Undergraduate vocational education
Technology requirement	Technology requirement	1. Training goal: Skilled workers in the technical department of a knowledge-intensive enterprise. 2. Job requirements: Have high practical skills. 3. Ability requirements: Have a certain skill level. 4. Talent positioning: For a specific technical job (Li & Xu, 2022).	1. Training goal: Technical engineers of high-tech industries in knowledge-intensive enterprises. 2. Job requirements: Have high operational and cognitive skills, be able to use, manage, and maintain new technologies, and undertake the management and training of senior technicians at the production site (Wang, 2020). 3. Ability requirements: Possess broader and deeper compound theoretical knowledge, higher skill level, specific management ability and development stamina. 4. Talent positioning: Serve high-quality tech talents in a specific vocational field (Wang, 2020).
Training methods	Major settings	Practice and operation of specific technologies and skills for a particular major (Song, 2012).	1. The coverage of professional knowledge is more comprehensive. 2. Practitioners need to meet the needs of three aspects: Have strong job adaptability, adapt to career changes, and have high sustainable development capabilities (Huang, 2019).
	Curriculum construction	It is based on the needs of a specific profession, and the basic theoretical requirements learned by the students are sufficient.	Its theoretical curriculum content is broader and more profound. It focuses on integrating curriculum content in similar disciplines and trains students to use knowledge to solve complex practical problems in production (Wang, 2020).
	Teaching practice	It adapts to the needs of a specific technical position and does not require high theoretical knowledge.	1. It emphasizes emphasizing theoretical and practical teaching; it trains students' ability to apply theoretical knowledge to solve practical problems. 2. It helps students understand and master the theory's practical application meaning and methods and focuses on training students' comprehensive skills (Ren & Ding, 2020).

Source: This thesis compiled

Research on the characteristics of undergraduate vocational education talent training:

The characteristics of undergraduate vocational education talent training can be compared with college vocational education and regular undergraduate education. Undergraduate vocational education is different from college vocational education. Their differences are mainly reflected in technology requirements and training methods (Table 2.2).

Compared with college vocational education, undergraduate vocational education trains talents with richer theoretical knowledge and more proficient practical skills. Also, their management and job transfer, technological innovation, and skill improvement ability are more vital.

Undergraduate vocational education is different from regular undergraduate education. Both belong to undergraduate education in higher education, and the differences are mainly manifested in five aspects: Training goal, training methods, university system, teachers, and student sources (Table 2.3).

In summary, vocational and regular undergraduate education have different talent training goals. The former is to train high-quality tech talents, and the latter is to teach academic skills. Based on this core difference, there

are differences between the two in terms of significant setting, curriculum setting, school-running system, faculty, and student source.

Table 2.3: Differences between Vocational and Regular Undergraduate Education

Project		Regular undergraduate education	Undergraduate vocational education
Training goal	Training goal	1. Training goal: It trains academic talents and focuses on cultivating fundamental theories and professional knowledge. 2. It emphasizes the systematicness and completeness of knowledge learned (Xia, 2007).	1. Training goal: It trains high-quality tech talents and focuses on applying fundamental theories and professional skills training practically. 2. It emphasizes students' practical application of the learned technology and knowledge (Zhang, 2019).
Training method	Major setting	1. It is a subject-based professional setting. 2. It mainly sets up majors according to the discipline system and the school's running characteristics, and its purpose is to train students to fully grasp a discipline's knowledge.	1. It focuses on the significant setting of critical national and regional economic and social industrial development areas. 2. Its primary setting serves new industry business formats and models, docking with new occupations, and focuses on related majors that need to be trained in the long-term education system (MOE, 2021).
	Curriculum construction	1. It is based on subject theory and emphasizes the depth and completeness of theoretical knowledge structure in content. 2. Its practical courses focus on verifying theories, and the experimental class hours only account for 20%-30% of the total class hours.	1. It focuses on integrating basic knowledge of the position and similar professional theoretical knowledge and expands students' professional knowledge. 2. Its practical teaching hours account for no less than 50% of the total class hours (MOE, 2021). 3. It needs a stable and sufficient number of training bases to meet the needs of teachers and students for internship training (MOE, 2021).
School-running system	School-running system	It focuses on academics, and its school-running system has a certain degree of closure.	Its school-running system is open and flexible, and industry enterprises participate in significant settings, curriculum construction, and practical teaching.
Faculty	Faculty	Theoretical teachers occupy a dominant position, with relatively few part-time teachers.	1. The proportion of "dual teacher" teachers is not less than 50%. 2. Part-time teachers from the front line of industry enterprises account for a certain percentage. Their professional courses are generally not less than 20% of the total professional courses (MOE, 2021).
Student source	Student source	Its student source mainly comes from general high school graduates.	It has a flexible and diverse source of students, including graduates from technical vocational education, social workers with specific practical experience, and even graduates from general high school education (Ma, 2015).

Source: This thesis compiled

Research on the specifications of undergraduate vocational education talent training:

The talent training goal is the "direction" that reflects society's overall quality requirements for talent. It is the prerequisite and basis for smoothly carrying out all education and teaching activities. It reflects society's expectations of education talent training activities (Liu, 2002). To a certain extent, the orientation of the talent training goal needs to consider three factors: The country's general education goal, the society's requirements for talent in a certain period, and the essential attributes of specific types of education. The talent training goal of undergraduate vocational education focuses on training high-quality tech talents. Its training goal includes the following core elements: Solid and profound technical and theoretical knowledge, strong practical application ability, specific creative ability, development potential, technology transformation ability, and good professional ethics. Also, it requires the ability to transform technical principles into physical entities to serve actual production departments such as production, construction, and management (Chen, 2020; Fang, 2019; Que et al., 2019; Yin, 2020).

The talent training goal reflects the school's requirements for talent training direction and training specifications. Talent training specifications are the specific and detailed training goal, the constructed element of talent training. It stipulates the direction of talent training, and it is an essential basis

for schools to formulate teaching plans and syllabuses, organize teaching and evaluate the quality of education (Chen & Pang, 2013). In this thesis, based on the specific requirements of social and economic development for talent training specifications, the researcher extracts and concludes that undergraduate vocational education talent training specifications should have three elements of knowledge, ability, and quality (Cui & Yao, 2023; Li & Chang, 2019; Liu, 2016; Ma, 2015; Song, 2012; Tian et al., 2017). Knowledge is the foundation of ability, the embodiment of the specific application of knowledge, and quality is the organic combination of knowledge and ability embodied in vocational and social activities. The three develop in a coordinated manner and jointly form an excellent comprehensive quality of the educated.

Knowledge construct elements. Different scholars have different expressions of knowledge construct elements. According to Song (2012), the knowledge construct components of undergraduate vocational education skills are broken down into general knowledge and specialized knowledge. Ma (2015) believes that humanities knowledge is broad and professional. Liu (2016) considers it divided into professional and basic cultural knowledge. Yi (2019) thinks it to be composed of professional and related knowledge. According to Huang (2020), professional and general knowledge is fundamental.

From scholars' viewpoints, it can be seen that scholars generally believe that the integration of professional and general knowledge characterizes the knowledge construct of undergraduate vocational education talents. Most scholars divide the knowledge construct elements of undergraduate vocational education talents into professional and general knowledge. Regarding professional knowledge, scholars believe that academic talents require a "profound" theoretical foundation, but talents trained in undergraduate vocational education need a "solid" theoretical foundation. "Solid" means that the theory mastered is accurate and realistic but does not require too much depth (Hu, 2019; Li & Chang, 2019). Regarding general knowledge, scholars believe that talents trained in undergraduate vocational education should have a "broad" knowledge construct. "Broad" refers to the basic theoretical knowledge of the subject that should be understood and known (Huang, 2019; Ma, 2015; Song et al., 2012). From the perspectives of scholars, the researcher believes that in terms of knowledge construct, talents trained in undergraduate vocational education need to have broad basic theoretical knowledge and solid professional theoretical knowledge.

Ability to construct elements. Different scholars' expressions of the ability to construct elements are inconsistent. Song (2012) believes that the ability construct of undergraduate vocational education talents is divided into general, professional, and development abilities. Li (2019) believes it includes

professional, method, and social ability. Hu (2020) believes it is divided into professional, comprehensive, and professional development abilities. From scholars' viewpoints, it can be seen that scholars generally believe that the ability to construct undergraduate vocational education talents has the characteristics of professionalism, development, and inclusiveness. Most scholars divide this talent ability construct into three categories: general, professional, and career development ability (Guo & Liu, 2017; Huang, 2019; Liu, 2016; Ma, 2015; Song, 2012). Scholars believe that general ability is a fundamental ability, which is an essential ability that people should have in any profession, including oral expression, written expression, foreign language application, information processing, organizational leadership, cooperation, and self-learning ability, etc. (Ma, 2015; Song et al., 2012). Scholars believe vocational ability refers to specialists' professional ability when working in a specialized field. Scholars believe vocational ability refers to the professional ability specialists must possess when working in specialized areas. It is the result of the outward expression of basic professional knowledge, basic professional skills, and essential qualities in the practical activities of the industrial field. It mainly includes job adaptability, operation, problem-solving, and innovation ability (Guo & Liu, 2017; Hu, 2020; Huang, 2019; Li, 2019; Liu, 2016; Ma, 2015). Scholars believe that career development ability refers to the ability to meet the needs of professional positions formed through intensive learning and practice based on professional ability. It can carry out

career conversion and migration (Hu, 2020; Huang, 2019; Li, 2019). Specifically, professional development ability is the extension and expansion of professional ability in the “deep” and “wide” dimensions. It mainly includes career planning, career change, migration ability, etc. To sum up, it believed that in terms of ability construct, the talents cultivated by undergraduate vocational education have the general ability, targeted professional ability, and career development ability that can be converted and transferred.

Quality construct elements. Quality is a spiritual quality based on a person’s innate endowment. Also, it is an internal, relatively stable psychological construct and quality level formed and developed under the influence of the acquired environment (Li, 2010). Scholars have similar expressions on the quality construct elements of undergraduate vocational education talents. Song (2012) believes it includes essential general and professional intelligence qualities. Li (2019) believes that it has psychological quality, humanistic quality, ideological and political quality, and professional quality. From scholars’ viewpoints, it can be seen that scholars generally believe that the quality construct of undergraduate vocational education talents has the characteristics of universality, discrimination, and inclusiveness. Most scholars divide such talents’ quality construct elements into personal and professional qualities. (Guo & Liu 2017; Liu, 2016; Ma, 2015; Meng, 2020). Scholars believe that personal quality refers to the essential quality that

students need to possess for any career in the future. It includes self-awareness, personal character, physical and mental health, and responsibility (Huang, 2019; Liu, 2016; Ma, 2015; Song & Tian, 2012). Professional quality refers to the quality that students need to have in any profession after graduation that matches the industry they are engaged in (Hu, 2020; Huang, 2019; Li, 2019; Song, 2012). The professional nature of different occupations is different, and the professional qualifications required for professional activities are also different. Specifically, the quality needed for undergraduate vocational education includes professional ethics, competitive awareness, reverse thinking, and craftsmanship. Combining the views of scholars, the researcher believes that in terms of quality construct, talents trained in undergraduate vocational education need unique personal and targeted professional qualities.

By analyzing the relevant research on undergraduate vocational education, it can be seen that the current research on undergraduate vocational education mainly focuses on macro aspects, such as the necessity of developing undergraduate vocational education and the characteristics, goal, and specifications of talent training. The micro-research on the development of undergraduate vocational education students is almost blank, reflecting this thesis's vital significance. In addition, it can also be seen that the talent training characteristics and specifications of undergraduate vocational education are closely related to China's social development needs. Therefore, this thesis

clarifies the specific connotations of knowledge, ability, and quality structural elements that talents trained in undergraduate vocational education need to possess, which can help undergraduate vocational education improve the quality of talent training, achieve talent training goals, and meet the needs of social and economic development.

2.2 Student Development

2.2.1 Development of Student Development Theory

Student development theory began in American higher education in the 1920s, and its development process is divided into three stages.

Stage One: From the end of World War II to the 1960s, the student development theory was influenced by two aspects. First is the rapid increase in American college and university students during this period. The second is the development of disciplines such as psychology and sociology. The research on student development theory at this stage is primarily for white male students, and the research angles are mainly from the perspective of psychology and sociology. The research results at this stage mainly include Sanford's research on the complementary effects of "challenge and support" in student development (Sanford, 1962). Chickering identified seven variables for college student development. He regarded student development as the goal and result of education (Thomas, 1984). Feldman published *Impacts of College on*

Students, which explored students' university experience and development from the perspective of social psychology (Feldman, 1969).

Stage Two: From the 1970s to the 1990s, the research on the student development theory was further developed. The research subjects have expanded from the American white adult male group to African American, Asian, female, and other groups. Scholars have conducted classified research on student groups of different races, ethnicities, and religious beliefs, female students, and gay students. The research hotspots of this period include college student development, the factors that affect it, and the relationship between student development and environmental influences. The main research results are divided into the following four aspects. The first is the study of the development of student's cognitive ability. Based on the theory of Swiss psychologist Piaget, it studied how students think and learn more complex ways of thinking, focusing on their cognitive and personality development (Bringuier, 1989). The second is the study of the internal and external factors of the impact of university education on student development in pedagogy and the relationship between the university education goal and student development elements. The former Soviet Union educator Zankov put forward the concept of "general development" in the book *Teaching and Development*, emphasizing the individual and ability standards of development (Davydov, 1998). Third, scholars in the field of sociology study the social development of

students and their preparation for future careers. For example, the sociologist Bandura believes that most human learning takes place in social situations, and development can only be truly understood from the perspective of social learning (Bandura, 1977). Fourth, scholars have more precisely interpreted the connotation of student development. According to Astin, student development comprises cognitive and emotional development (Astin, 2012). While emotional development encompasses attitudes, values, and other things, cognitive development includes knowledge and skill development. Student development involves cognitive learning, practical skills, and emotional and moral development, according to Bowen (1977).

Stage Three: Since the beginning of the 21st century, the student development theory has achieved more fruitful results. The focus of the research at this stage is mainly the connotation of student development and the realization method of student development. American psychologist Sanford pointed out that student development is a positive development process. Students participate in education and activities during college, integrate into the group, and can obtain different aspects of experience. Therefore, he believed that student development could change students' thoughts, emotions, behaviors, and values (Hamrick, 2002). The well-known educational psychologist Carl Rogers pointed out student development was how students grew. It refers to students' ability development, progress, and growth after

entering colleges and universities. Also, he believed that the purpose of education was to encourage students to learn and promote student development (Hamrick, 2002). The Council for Higher Education Accreditation (2003) proposed that student development results from students' higher education experience and the knowledge, skills, and abilities they acquire at the end of their higher education experience. Although different scholars have different discussions on the realization of student development, they generally believe that school education is the main driving force for student development.

2.2.2 Classification of Student Development Theories

There are three representative student development theories. They are social psychology theories, cognition and value theories, and individual and environmental theories. On the one hand, the student development theory research trend shifts from studying a specific aspect of student development to focusing on overall student development. On the other hand, it has entered the field of pedagogy from psychology research. Also, it should be emphasized that the three theories are not entirely separate. Scholars' research sometimes involves multiple theories, and it isn't easy to classify them into a specific theoretical type. This thesis will introduce several major student development theories and representatives of each theory.

Social Psychology Theory. It focuses on the different stages of student development, and a student's individual development is a series of "developmental" tasks. Scholars focus on the stages, continuity, and richness of student development. In 1950, Erikson proposed the social psychology theory based on his life cycle theory. Scholars believe that individual development is affected by growth environment, social culture, and other factors. Personal development must face a series of challenging problems that must be solved, corresponding to the different stages of individual development. Individual life has "stages" with varying tasks of development. The stages of personal development range from simple to complex and each stage is based on the previous stage. After the individual has completed the developmental task of this stage, he can develop to the next stage. Most social psychologists believe that the successful solution of each task can help individuals solve subsequent tasks, significantly impacting the speed and degree of individual social and psychological development. Scholars also pointed out that individuals do not complete each stage of development tasks in the same order and way (Pascarella & Terenzini, 2005). Chickering is a famous scholar who practices this theory in education field. His seven-vector student development theory reflects student development in different fields and levels (Thomas, 1984).

Cognition and Value Theory. The basis of this theory is Piaget's structural theory of cognitive development, which discusses student development from

the perspective of cognitive development. In 1968, William Perry put forward the theory of students' intellectual and moral development. Central to the study of this theory is the process of students thinking development, which progresses from viewing problems method in dichotomous perspectives to mastering multiple perspectives and students being able to make comparative judgments about these perspectives (Perry,1968). William Perry divides the student's development process into three stages: "Basic duality," "Multiplicity," and "Commitment". The way students in the "basic duality" stage view problems are dualistic, either right or wrong. Students cannot accept uncertainty and intermediate states. At this stage, the teacher is authoritative, and students believe that the knowledge imparted by the teacher is correct. Students in the "multiplicity" stage no longer cling to absolute right and wrong views. They believe that knowledge is indeterminate in the general sense and that every viewpoint has value. The prominent characteristic of students in this stage is to challenge authority and view the world relativistically. Students in the "commitment" stage can deal with uncertainties and distinguish the authenticity of knowledge, the highest stage of cognitive and moral development (Perry, 1968).

Individual and Environmental Theory. This theory studies student development from the relationship between personal and environmental development. In 1977, the Input-Environment-Output Model (I-E-O Model)

proposed by Astin was the earliest and most influential model in this field. In this model, the student's learning outcomes are a function of the student's input and the campus environment. Student input affects their learning outcomes. Students' experiences and information, and perceptions of the campus environment differ. Therefore, students' learning outcomes differ (Astin, 1977). According to this model, Astin proposed the student involvement theory. He believes that the more time students invest in meaningful learning, the more effort and energy they put in and learn (Astin, 1985). However, this theory also has limitations. It only examines students' learning effectiveness from the time and energy invested in learning. The final learning outcomes of students are highly related to all aspects of student college life.

When looking at students' learning outcomes, universities need to focus on the campus environment to promote students' participation in learning. Sanford's "Challenge and Support Theory" pays attention to the role of the college. He believes colleges and universities should give students enough academic challenges to maximize student development. Also, they should provide sufficient support to students (Sanford,1962). More importantly, colleges should strive to balance challenge and support. If the college gives students too high a challenge that makes them unbearable, they will retreat passively. On the contrary, if the challenge is too low, students will be able to complete it quickly, and students will become lazy and lose the motivation to

sprint towards higher goals (Patton, 2016). Researchers believe a sufficiently challenging and supportive environment can promote student development most effectively.

In summary, different student development theories have different focuses. Individual and Environmental Theory emphasizes internal and external environmental factors. It does not mention which aspects of students have been developed. Social psychology and Cognition and Values Theory specify various elements that include the intra-and inter-individual factors and do not consider the campus or environmental factors. The Social Psychology Theory is student-centered and pays attention to the content and stages of student development. Its feature is very similar to the viewpoint of this thesis. Therefore, the Social Psychology Theory is one of the essential theoretical basis for this thesis.

2.2.3 Research Status on Student Development

There are two characteristics of Chinese research on student development. Initially, compared with foreign countries, Chinese scholars started their research on student development relatively late, starting in the 1980s (Zha, 2016). Besides, Chinese scholars' research on student development is mostly empirical research that draws on Western student development theories and then combines them with the actual development of Chinese education. In

terms of research content, Chinese scholars mainly conduct research on three aspects: the student development environment, influencing factors, and evaluation.

Research on the student development environment. Scholars draw on Western individual and environmental theories to study the impact of social and educational settings on student development. Different scholars have selected different development environments to conduct research. They focused on the effects of a specific environment on student development. Cui and Liu (2003) studied the influence of the internet on students' social development. They evaluated 110 Shanghai undergraduates' internet access and their three aspects of social action: trust in others, subjective well-being, and social alienation. Zhou (2011) explored the impact of mobile phones on student development. Through questionnaire surveys and interviews, he found that mobile phones positively and negatively affect students' studies or lives, interpersonal relationships, and psychological development. In addition, they have put forward some countermeasures in terms of higher education, teaching, and school management. Zha (2017) discussed the impact of reading on students. She investigated the effects of reading on students' value, knowledge acquisition and innovation ability, cognitive thinking ability, expression ability, and psychological quality. The research results show that reading has a positive impact on student development.

From the research results of scholars, it can be seen that all aspects of social life positively or negatively impact student development, especially the environmental factors closely related to students' study, energy, and growth. In studying student development, researchers need to focus on environmental factors closely related to student development and play to the positive influence of ecological factors.

Research on the factors affecting student development. Since 2010, scholars have used Western university student development theories to research the influencing factors of college student development, a new development in China's research. These studies focused on the effects of interpersonal interactions, student engagement, school engagement, and learning patterns on college student development. Based on Western student development theory, Zhu Hong analyzed the influence mechanism between student participation and university student development using the 2010 "Capital University Student Development Survey" data as a research sample. Research results showed that the degree of student participation in study and life is the most critical factor affecting student development (Zhu, 2010). Zhao (2014) took students from five universities in Tianjin as the research subjects. He analyzed the impact of student participation and student background characteristics on student development. The research results show that student participation directly

impacts student development, while students' perception of the campus environment indirectly impacts student development. Student background characteristics play a moderating role in the influence of student participation and development. Guo (2014) used students in a specific university as the research subjects to explore the impact of university education on students. Research showed that students' personal and family backgrounds have little effect on their development during university. The difference in student development mainly depends on the student's learning time spent and university investment. The degree of support of the campus environment, academic challenge, and the perception and attitude of students toward the university environment all affect student development. Also, students' time and energy on practical learning activities affect student development.

Scholars study the relationship between school and student development, focusing on school investment and student participation in campus life. Universities are the main driving force of student development and an essential aspect of studying student development issues.

Research on the student development evaluation. Scholars generally believe that the essence of the assessment of student development is evaluating the quality of talent training in universities. Different scholars have expressed their opinions on evaluation methods and evaluation system construction. Zhu

(2010) discussed evaluating talent training quality in Chinese universities from the perspective of student development theory. He believes colleges and universities should focus on combining educational output and the educational process. He thinks the traditional quality evaluation of talent training in Chinese universities is qualitative. Universities should make breakthroughs in quantitative research methods based on determining scientific training goals and constructing scientific evaluation tools. Li (2013) studied the relationship between student development evaluation and higher education quality assurance. She proposed that colleges and universities need to make breakthroughs in evaluating the quality of Chinese higher education by using student development evaluation. First, scholars need to build a Chineseized student development theory.

Furthermore, they should construct an assessment index system for college student development and develop localized assessment tools. In addition, they may use Chineseized evaluation tools to collect data on students' general skills, professional skills, and non-cognitive ability and then establish a student development database for longitudinal research. He (2019) used the student development index to evaluate student development. He tracked the student development data of year one university students for four years and explored the law of student development. He also put forward countermeasures and suggestions to improve the student development index.

We can see that universities' talent quality evaluation system is incomplete and does not fit well with student development indexes. It is also the key research question and research value of this thesis.

In summary, Chinese scholars have insufficient research on Chineseized student development theories and evaluation tools. Also, they have very few in-depth studies and targeted suggestions on student development in a particular type of university. It is the practical significance of this thesis.

2.2.4 Use of Student Development Instruments

To better study student development, scholars in China and abroad have devised a series of questionnaires to measure the quality of student development as a tool to measure the student development level. The working principle of these evaluation tools is that they can evaluate student participation, institution investment, and student development level, thereby assessing the quality of college education.

Research by foreign scholars on student development assessment tools:

The most representative evaluation tools abroad are the "College Student Experiences Questionnaire" (CSEQ) and the "National Survey of Student

Engagement" (NSSE).

In 1979, Pace developed the American CSEQ (Pace, 1998). He used it to evaluate the autonomy and effectiveness of students in using higher education resources and educational opportunities. The content of CSEQ includes students' basic information, campus activities, campus environment experience, student development, etc. The campus activity survey is the core part of the questionnaire. It covers almost all students' learning behaviors from enrollment to graduation, such as course study, extracurricular activities, teacher-student interaction, peer interaction, etc. The campus environment experience survey can understand students' evaluation of the campus environment. The student development survey involves general education, personal development, scientific and technological knowledge, and professional and practical ability. These contents are important indexes to evaluate the effectiveness of student development.

In 2007, the American Pew Charitable Trusts launched the NSSE. This questionnaire investigated the education investment of four-year undergraduates in the United States. It listed five indexes: academic challenges, active and cooperative learning, teacher-student interaction, rich educational experience, and supportive campus environment. In addition, NSSE also contains three types of information: basic student information, student development, and student satisfaction with the college. NSSE investigated

student development from the three dimensions of knowledge, ability, and value. It is worth noting that the NSSE project team divided participating colleges and universities into eight categories: research universities with very high and general high research strength, etc. They built a national norm for various colleges and universities based on the results of the annual survey data.

Chinese scholars' research on student development assessment tools:

Chinese scholars' research on student development instruments began in the 1990s, and they are the result of localized improvements of classic measurement instruments from other countries. They are used primarily to study how colleges and universities are concerned about students' participation in their studies and life and to ensure and promote student development. The representative evaluation tools for student development in China include the "Ten Years of Shanghai University Student Development" biennial research project, the "Beijing University Student Development Status" annual survey project, and the "China College Student Survey".

The "Ten Years of Shanghai University Student Development" biannual research project (1998-2007) hosted by Fudan University is an early project for Chinese student development. The project used sample surveys and case interviews to study value development. Its evaluation indexes include students' basic personal information, learning status, employment issues, campus

activities, and value. Scholars analyzed the situation of Shanghai students' study, part-time jobs, network experience, and interpersonal communication as their cognition and evaluation of occupation, religion, politics, value, and life concepts. They also evaluated the value development of Shanghai students during the ten years from 1998 to 2007.

In 2006, Peking University launched the annual "Beijing University Student Development Status" survey project. Researchers investigated students' development level and learning input in different types of colleges and universities in Beijing. They focused on students' learning and social-emotional participation, feelings and satisfaction with the university environment, self-awareness and social cognition, and academic achievements. This survey tool refers to the NSSE survey of Indiana University, the College Student Survey (CSS) of the University of California and Los Angeles (UCLA). Researchers designed a questionnaire based on the characteristics of Chinese higher education students. Beginning in 2010, Beijing has relied on Peking University to publish the annual *White Paper on Peking University Student Development*.

In 2007, scholars at Tsinghua University introduced China's internationally renowned NSSE questionnaire. They combined the actual situation of China's higher education to Chineseize the NSSE topics and

designed the “China College Student Survey (CCSS),” also known as the NSSE-China. In 2009, Tsinghua University revised its questionnaire. The evaluation concept of the project is to add value to education, the subject of evaluation is students, and it focuses on assessing the educational process. The reliability and validity of the questionnaire have also been tested. Tsinghua University organized students to participate in the student development evaluation and formed a study report of Tsinghua University. The same year, Tsinghua University surveyed universities of different types and regions in China. It is the first large-scale survey conducted after the questionnaire was Chinese. As of 2019, more than 150 universities in China use CCSS to conduct student development surveys. The survey scope covered 28 provinces (municipalities and autonomous regions) in China. The colleges and universities participating in the project can discover their problems in student training and the directions for improvement. The CCSS questionnaire is divided into three categories: green questionnaire, yellow questionnaire, and purple questionnaire, which are correspondingly used in regular universities, vocational colleges, and Tsinghua University. CCSS is highly recognized in China. It is the most extensive and longest-lasting student development questionnaire. In recent years, most of the research samples related to Chinese student development come from CCSS survey research data, such as Wang’s (2014) study on the impact of students’ extracurricular learning investment on student development, Wang’s (2016) research on the influencing factors of

undergraduates' university satisfaction, Yang's (2018) student development index: structure and level. He's (2019) study of the level change trajectory of the student development index and its influencing factors.

In summary, the design of student development instruments in Chinese vocational universities is still blank. Therefore, the student development instrument designed in this thesis has important practical significance. And it has three characteristics. This thesis fully draws on predecessors' research methods and content and enriches and develops China's existing student development measurement tools. This thesis's measurement tools align with social needs, Chinese vocational universities' development, and talent training's goal and specifications. This thesis used the evaluation tool to obtain detailed vocational university student development data. Based on the results of the data analysis, this thesis put forward suggestions for student development. It can help universities improve talent training quality and cultivate high-quality technical and skilled talents that society needs.

2.3 Outcomes-Based Education (OBE)

2.3.1 Development of OBE Theory

OBE has important theoretical guiding significance for this thesis. This section will introduce the proposal and development of OBE.

The proposal of Outcomes-Based Education (OBE) theory:

American scholar Spady proposed the OBE theory in 1981 (Spady, 1981). He believes that students obtain learning outcomes through receiving education, which is the goal of curriculum design and implementation. He paid more attention to students' behavioral consequences after learning, focusing on what students can do after learning rather than what they have learned. The OBE theory clarifies four core issues (Li et al., 2014). Firstly, what learning outcomes should students attain? Second, why should students accomplish these learning outcomes? Third, how can teachers best support students in achieving these learning objectives? Fourth, how to determine whether or not students have met these learning objectives?

Spady put forward the concept of the OBE Pyramid in his book *OBE: Critical Issues and Answers* (Spady, 1994). The outcomes-based pyramid is divided into five levels: one paradigm of operating, two essential purposes, three fundamental premises, four operating principles, and five generic domains of practice (Figure 2.1).

One paradigm of operating. Before implementing OBE, researchers need to have a clear operating paradigm, clearly pointing out the core competencies students should possess in different aspects. Then, they design course

objectives, content, implementation, and evaluation around this operating paradigm to help all students achieve the expected paradigm of operational goals. This functional paradigm is located at the top of the pyramid and determines other pyramid groups' design schemes and implementation paths.

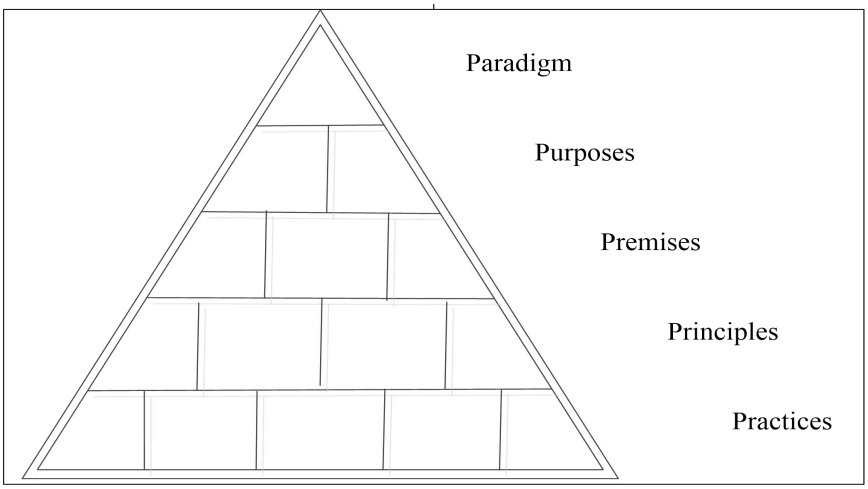

Figure 2.1: OBE Pyramid

Source: Spady (1994)

Two key purposes. Specifically, an essential purpose is to establish a clear blueprint or expectation of learning outcomes. The content of the blueprint is that students need to achieve the knowledge, abilities, and accomplishments required by the paradigm of operating when they graduate. Another fundamental purpose is to create an environment and opportunity for all students to achieve the desired outcomes.

Three key premises. One is that all students can learn and succeed, but not

at the same time or in the same way. The second is that successful learning can promote more successful education. Third, the college's various tasks, resource allocation, and equipment implementation will affect whether students can study successfully.

Four operating principles. The first is to focus on the peak learning outcomes. The second is to expand opportunities and support successful learning. The third is high expectations that all students will be successful. The fourth is to reverse design the curriculum based on the peak learning outcomes and determine all the teaching links toward them (Li, 2015).

Five generic domains practice. The OBE theory consists of five implementation steps (Wang, 2019). They are first defining the outcomes. Before implementing OBE, researchers must clearly define outcomes. The expected outcomes guide all educational activities and the criterion of student success. Second, designing the curriculum. Learning outcomes represent a kind of ability structure realized through course teaching. Therefore, the construction of course content is significant. There is a clear correspondence between learning outcomes and curriculum structure, and an explicit curriculum should support each learning outcome. Third, teaching strategy. OBE-based teaching emphasizes what students have learned. What can they do? It focuses on output and ability instead of input, guiding students to think

instead of direct indoctrination and personalized teaching. It also encourages critical thinking, communication, reasoning, comment, feedback, and action. Fourth, examining the results. OBE focuses on learning outcomes. It provides targeted evaluation and input based on the degree to which students meet learning outcomes requirements. It provides a reference for colleges and teachers to improve teaching by accurately grasping students' learning status. Fifth, determining advancement. OBE emphasizes that all students should have the opportunity to study successfully. It sets several stages in the learning process of students. It determines the learning objectives of each stage so that students can reach the expected results from the elementary to the advanced step in the process and gradually achieve success.

Development of Outcomes-Based Education (OBE) theory:

Based on Spady's research, domestic and foreign scholars have made further research and development on OBE.

The development of OBE theory in other countries. Foreign scholars have enriched and developed OBE theory in three aspects. The first is the research subject of OBE theory. The scholars further clearly defined the subject of OBE theory as the student. This theory is student-centered, results-oriented, and expects all learners to learn and succeed (Towers, 1996). The second is the four basic principles of OBE theory: a clear focus on outcomes, reverse design,

giving continuous and higher expectations for success, and expanding opportunities. It points out the direction for OBE theory to be used in practice. The third is the advantage and potential of OBE theory. Harden (2007) combed the development process of OBE theory from 1981 to 2002 and concluded twelve benefits of OBE theory compared with traditional education theory.

The development of OBE theory in China. The research on OBE theory started relatively late in China, and the first region to use this theory was Hong Kong, China. They carried out OBE theoretical research in 2005 and then promoted this theory. The research focus of scholars is the OBE theory to guide the cultivation of talents in colleges and universities and its application in the educational reform of colleges and universities. In 2012, OBE theory gradually entered the research field of scholars in mainland China. They made a further understanding and interpretation of the OBE theory. Shen (2016) interpreted the definition, measurement, and evaluation of the OBE theory's learning outcomes, analyzed the theoretical origin of OBE theory, and used OBE theory for teaching design. Gong (2016) paid attention to the creation of learning outcomes. He drew on the OBE theory's strong operability and evaluability advantages. He put forward several suggestions that are helpful to the design of learning outcomes: focus on top-level design, reform evaluation methods, the implementation of continuous improvement, and the central role of teacher development.

2.3.2 Application of OBE Theory

In education, OBE theory is widely used in the United States, Canada, Australia, South Africa, and other countries and regions, and they have accumulated a lot of practical experience. In recent years, Chinese scholars have also widely used OBE theory to carry out higher education practice research, which mainly includes five aspects.

OBE theory is prevalent in evaluating “student learning effectiveness”. In 2007, the United Nations Educational, Scientific, and Cultural Organization first defined “student learning effectiveness,” which refers to the intelligence and technology that learners should understand, master, and be able to demonstrate after completing a particular unit hour, course, or learning process. Student learning effectiveness is an essential index for evaluating the quality of university training (Huang, 2010). Therefore, scholars have conducted many empirical studies on student learning effectiveness recently. Song(2018) pointed out that colleges and universities should use the OBE theory as a guide and pay attention to the learning effectiveness obtained by students in terms of knowledge, ability, and quality. They need to evaluate student learning effectiveness in a diversified manner. This evaluation will become the starting point for reforming the quality evaluation of university talent training. Zhai (2018) used the OBE theory to evaluate student learning effectiveness. He also

gave examples of the meaning, type, implementation, and evaluation of learning outcomes. Wang (2019) also put forward a theory similar to OBE. He believes that the achievement of student learning outcomes is not only judged by the final exam results but also should pay attention to the value-added situation of students in terms of knowledge, ability, and quality. Colleges and universities should focus on applying the evaluation results to continuous improvement and enhancing student learning effectiveness.

OBE theory for education quality accreditation evaluation. The field of engineering education certification was the first to use OBE theory to evaluate the quality of education. According to the requirements of OBE theory, engineering education certification majors must clarify learning outcomes, arrange teaching activities according to learning outcomes' needs, and evaluate learning outcomes achievement. The American Engineering and Technology Education Certification Organization launched the engineering course certification standard EC2000. The core meaning of this standard is that learning outcomes are the basis for evaluating teaching effectiveness, and colleges and universities need to improve the teaching process based on learning outcomes. The method of ensuring learning effectiveness of the International Higher Business Management Education Alliance and the "student learning achievement-based evaluation model" of the American Western Association of Schools and Colleges (WASC) both applied the OBE

theory (Hong & Wu, 2015). The Hong Kong University of Science and Technology draws on the accreditation standards of the American Engineering Technology Education Accreditation Board. It divides engineering education's "three-line mode": professional engineer training, postgraduate training, and diversified career development training. Zhao (2016) drew on OBE theory to help engineering education majors construct a curriculum system, reform classroom teaching, and conduct curriculum evaluation. Many colleges and universities have used the above research to promote engineering education reform.

OBE theory is used in curriculum setting and reform. Under the guidance of OBE theory, Kem and Thomas (1998) proposed six steps in the construction of medical education courses: student needs evaluation, education goal, education strategies, implementation, assessment, and feedback. The focus of teaching is on student learning outcomes. In 2005, Taiwan in China began to study the guiding role of OBE theory in the field of the university curriculum. Feng Chia University applied the OBE theory to analyze the needs of the social industry, combined it with the university's orientation, and formulated the goal of students' personal development and quality training. This goal has two core functions. It can guide the improvement of internal and external curriculum mechanisms, formulate curriculum goals, and match students' core abilities when they graduate and five years after graduation. It may implement the

curriculum plan and conduct periodic self-evaluations and continuous improvement (Li, 2023). Li (2010) also applied OBE theory in the design of the Introduction to Hotel Management course. Its curriculum model is arranged to teach content from the perspective of improving students' abilities and effectively evaluates students' learning achievements. This course forms a virtuous circle mechanism of teaching-learning-evaluation, which enhances the quality of course teaching and the quality of university talent training.

OBE theory is prevalent in teaching design and teaching model reform research. OBE theory is mainly used in teaching design and mode reform in two aspects. Scholars used the OBE theory to discuss the teaching model's significance, characteristics, implementation methods, and main points (Feng & Feng, 2023; Wang, 2017; Zhang & Yan, 2023). Besides, they applied OBE theory to the teaching design and model reform of a specific major and course (Li et al., 2023). Li (2015) relied on the automation major of a university to precisely interpret the ideas, strategies, and critical points of the reverse design. He used specific examples to illustrate the reverse design method, determining the training goal, constructing the curriculum system, and evaluating teaching quality. Zhao (2016) applied OBE theory to improve management courses' training objectives, curriculum design, and teaching content. Wang (2018) and Zha (2019) also integrated the OBE theory into the teaching design of project-based courses. They reverse-designed course objectives, teaching

projects, implementation and evaluation, and teaching improvement methods. Instructional design highlights the central position of students and optimizes instructional design and multiple assessments. It can be seen that the OBE theory advocates a "student-centered" organization of teaching, considers the differences in students' abilities in the design of the starting point of learning, and uses diversified teaching evaluations. It helps reform the teaching model.

OBE theory is used in colleges and university's reform and development practices. Scholars such as Gu (2014) applied OBE theory to study the engineering education model of Shantou University. The research content includes the practical structure, implementation characteristics, and implementation priorities of the engineering education model. The results of the empirical research show that the practice of this engineering education model is a very effective teaching reform strategy for Shantou University. Wang's (2016) *Outcomes-based Higher Vocational Curriculum Development* and *Outcomes-based Higher Vocational Curriculum Development Case Collection* studied the curriculum system reform of Heilongjiang Vocational and Technical College. He used OBE theory to establish core competence indexes, adjust the curriculum structure, design and develop curriculum syllabus and unit teaching, and diversify evaluation. It has completed the integration and optimization of the university's curriculum system. OBE is incorporated into the book "*Exploration and Practice of Talent Training Based*

on DQP Outcomes-based: The Application Practice of Chinese Qualification Framework in the United States, edited by He (2017). It can effectively solve the problems of the professional talent training model in higher vocational education and improve the level of vocational education in China. Wang (2023) elaborated the concept and practice of teaching reform of environmental science courses integrating Outcome-Based Education (OBE) in the context of new engineering construction and made a preliminary exploration of course content, teaching design, assessment, and evaluation.

From the research on the development and practical application of OBE theory by scholars, the development of OBE theory can be summarized in three aspects. In terms of research history, it has gone through theoretical exploration (such as concept definition, principle combing, etc.) to the practical application in the field of engineering certification and then developed to the practical application of various disciplines and professions. From the research perspective, it has gone through the process of exploration and practice from the macroscopic education concept of talent training to the microcosmic-specific majors and specific courses. The research subject has changed from the creation of European and American scholars to the inheritance and innovation of scholars from mainland China.

2.3.3 Advantages of OBE Theory Applied to Student Development

The OBE theory is suitable for the student development research of this thesis. Foremost, the research subject of OBE theory is consistent with that of student development in this thesis. OBE theory considers students the main body of education and focuses on students' learning and growth. The subject of student development in this thesis is also students, focusing on the in-depth development of students. Secondly, the OBE theory's research goal is consistent with student development in this thesis. This theory emphasizes the learning outcomes of students upon graduation and what they can do. This thesis's student development highlights students' behavioral results and ability level upon graduation, which are essential indexes for evaluating student development. Therefore, their research goal is consistent. In addition, the educational model of OBE theory is suitable for student development research. OBE theory is a reverse design. Its implementation steps are defining learning outcomes, designing learning content, formulating implementation strategies, evaluating results, and improving education and teaching to achieve learning outcomes. This thesis uses OBE as the theoretical basis to design the student development research process: first design a student development construct, then use this construct as a guide to evaluating the student development level, and finally put forward suggestions for improving the existing student development path to realizing the student development construct. It is a closed loop of student development research, which can help universities gradually improve the process of student development. Also, it can help students achieve

further self-development. Therefore, applying OBE theory to student development research can improve the consistency of student development goals and development results.

OBE theory is the enrichment and development of student development theory (Table 2.4). The advantages of using OBE theory to study student development are mainly reflected in three aspects. In terms of a research goal, many current types of research on student development focus on the comprehensiveness of learning conditions, such as college courses, internships, and educational activities. They pay more attention to research education investment. However, the OBE theory studies the results of students' behavior. It focuses on students' abilities after studying, and evaluating students' development tends to be an ability evaluation. In research design, many current student development studies are cheerful designs. They first set educational goals and paths and then implement educational investment to achieve the educational purpose of student development. However, OBE theory is a reverse design. Its logical starting and ending point are student development outcomes. It reverse-designs the dimensions and indexes of the student development construct according to its expected effects and evaluates and improves student development. In the items of application of evaluation results, the current evaluation of student development is static. Its evaluation results provide evidence for colleges and universities to adjust training goals, increase

education investment, and improve teaching methods. However, evaluating student development based on the OBE theory is dynamic. Its evaluation results continuously improve the student development construct (expected outcomes of student development) and existing student development paths and measures. Especially in the field of student development in vocational universities, OBE theory can help vocational universities clarify their talent training goal and paths, especially in student development in vocational universities. Also, OBE theory can provide a basis for their continuous improvement, which can help universities improve the comprehensive ability of graduates so that they can better adapt to society's requirements for high-quality tech talents.

Table 2.4: Enrichment of Outcomes-Based Education (OBE) Theory to Student Development Theory

Items	OBE	Conventional student development	Benefits of OBE for student development
Goal	It focuses on learning outcomes, forms transferable practical knowledge, teaching and education judgments, decision-making and evaluation capabilities, and helps students develop and grow professionally.	It tests knowledge and skills and expects students to have solid theoretical knowledge and proficient technical skills to prepare for entry.	First, it constructs a clear blueprint for student development outcomes. Then, it reverse-designs the content, implementation, and evaluation of student development. It sets the weights of the student development construct in different dimensions, which can help teachers and students clarify the degree of effort they should put into other aspects.
Content	It emphasizes practical knowledge and ability integration. Its educational content arrangements corresponded to the learning outcomes.	Its content includes regular teaching, activities, internships, training, etc.	It designs specific elements and indexes of student development based on the blueprint of student development outcomes to achieve vertical connection and horizontal integration.
Implement	It emphasizes collaborative guidance. It strengthens communication and cooperation among teachers and cooperative learning with peers. It is student-centered and outcomes-based, including implementation strategies such as diagnosis, evaluation, and feedback.	It follows the college's educational and teaching procedures, time, and schedule.	It focuses on development outcomes and creates an environment for its successful development. It fully considers the diversity and differences of students and encourages different students to adopt different development approaches. It enables teachers to coordinate and guide students to obtain better and more comprehensive development.
Evaluation	Its evaluation focuses on ability-oriented and multiple assessments, students' highest self-performance standards, and comparison of connotations. It is often used to evaluate conformity /non-conformity, passes/fail, and achievement/failure.	Its evaluation focuses on the comparison between students, often using poor/medium/good/excellent grade evaluation. It often lacks feedback and improvement measures.	Its evaluation emphasizes student-centered, student development outcomes-based and constructs a two-level assessment based on the development process and results.

It can be seen that using OBE theory to study student development is a relatively new research model. OBE theory emphasizes the subject status of students. Its evaluation of student development no longer focuses on subject content design and teaching but on improving student behavior and the growth of ability, which provides us with a more appropriate research perspective. However, this thesis is not a complete denial of the conventional evaluation model of student development. This thesis is based on the OBE theory. It starts with the design of the student development construct (student development expected outcomes), which can enhance the consistency of student development goals and development results, thereby improving student development. Specifically, this thesis uses the Fuzzy Delphi Technique to design the student development construct's specific dimensions and index content. Then, it uses a quantitative evaluation method to evaluate student development. Finally, it compares the evaluation results with the expected outcomes of student development and puts forward reasonable suggestions to improve student development.

2.4 Theoretical Framework

This research contains two parts of theoretical basis. OBE and the student development theory will be integrated to explain the basis of the research framework and student development construct design.

The theoretical basis of this research framework is the implementation process of OBE theory. The research purpose of OBE theory is consistent with that of student development. The OBE theory emphasizes the student's learning outcomes, and the student development theory emphasizes the student's behavioral effects and ability level at graduation. Both of them are outcome-based. The research subject of OBE theory is consistent with that of student development theory. Both theories take students as the main subject and pay attention to the learning and growth of students. Therefore, the implementation process of OBE theory is suitable for student development research. It includes defining learning outcomes, formulating implementation strategies, evaluating learning results, improve education and teaching (Figure 2.2). This thesis is based on the implementation process of OBE theory in designing the research framework of student development that first design the student development construct, then evaluate the student development level. Last, it put forward countermeasures to improve students development (Figure 2.3).

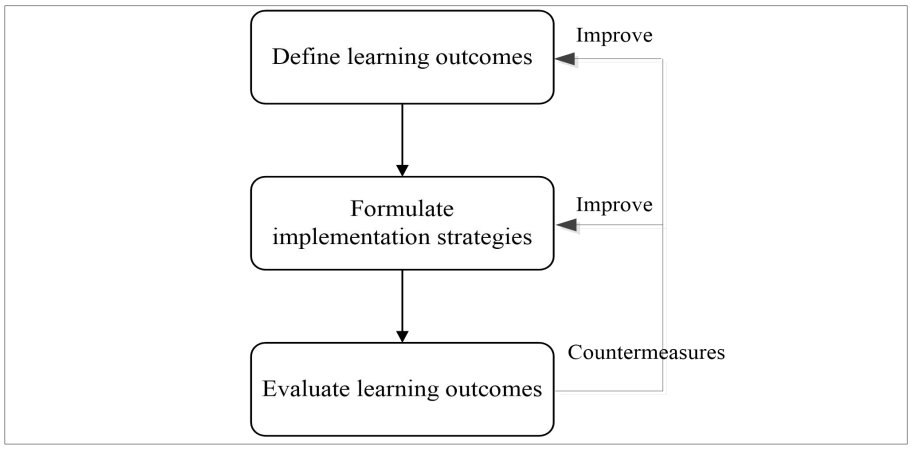

Figure 2.2: Implementation Process of OBE Theory

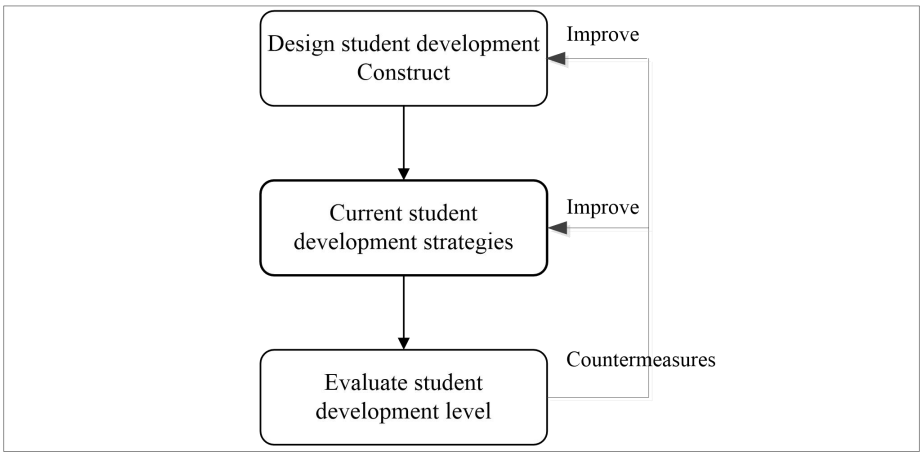

Figure 2.3: Research Framework of Undergraduate Vocational Education Student Development Based on OBE Theory

The student development theory is the theoretical basis of the design of the student development construct. According to the literature review of the student development theory in Section 2.2, the researcher concludes that the student development construct is divided into cognitive and non-cognitive development. Cognitive development divides knowledge and ability development, and non-cognitive development consists of value and quality development. This thesis research content is based on the student development theory.

2.5 Chapter Summary

This section summarizes related research on undergraduate vocational education, student development theory, and OBE theory. Undergraduate vocational education research clarifies the characteristics and specifications of undergraduate vocational education talent training. It identifies the knowledge, ability, and quality construct elements that undergraduate vocational students

need to possess. To a certain extent, these studies can provide a theoretical basis for studying undergraduate vocational education student development construct. The study of student development theory states the relevant theoretical foundations, the status quo of Chinese student development research, and typical measurement tools, which can help this thesis determine the dimensions of the student development construct. Also, it reflects the vital significance of this thesis. OBE theory research summarizes the theory widely used in various empirical studies in China. It also shows the appropriateness and advantages of OBE theory for student development research. It provides strong evidence for using OBE theory in student development research.

CHAPTER 3

RESEARCH METHODOLOGY

The research method is the way to achieve the research goals, and the appropriate research method is used to achieve the goals better. The research objectives of this thesis are divided into four parts: analyzing the necessity for a student development construct design, designing a student development construct, evaluating the student development index level, and proposing countermeasures to improve the student development level in undergraduate vocational universities. This chapter discusses in detail the methodology to achieve the research goals. This thesis used the interview method to analyze the necessity of student development construct design. It adopted the FDT to design the student development construct, applied AHP to assign index weight, and the survey method to evaluate the student development level.

3.1 Research Design and Development

Following the implementation process of OBE theory, this thesis is a four-stage design: analysis of the necessity of designing the student development construct design (Chapter 4), design of the student development construct (Chapter 4), evaluation of student development level (Chapter 5), and countermeasures to improve the student development level (Chapter 5). Figure

3.1 provides a detailed explanation of the research design and each stage.

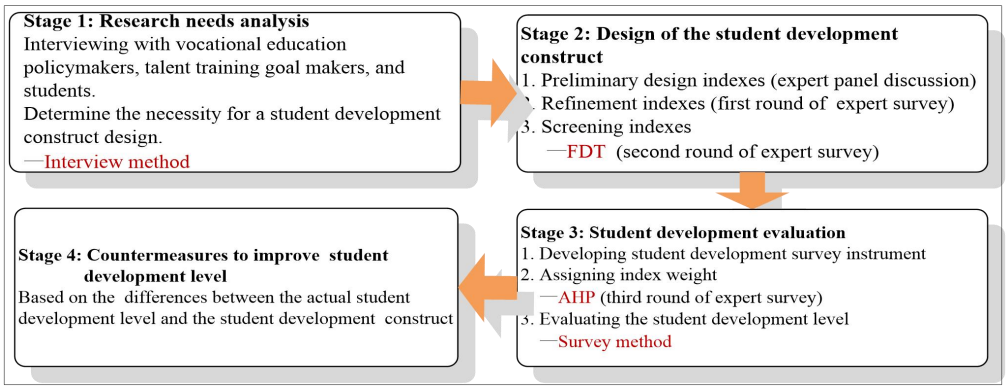

Figure 3.1: Design of Undergraduate Vocational University Student Development Research

Stage One (Necessity analysis). This stage is the prerequisite for this research design. It answered research question 1. The researcher analyzed the necessity of student development construct design by interviewing vocational education policymakers, undergraduate vocational university talent training goal makers, and students.

Stage Two (Student development construct design). This stage is the key to this research design. At this stage, research problem 2 was solved. This stage clarified the content of applying the FDT to design the undergraduate vocational university student development construct. The design of it was divided into three steps. Firstly, a discussion panel of six experts and the researcher preliminarily designed the construct indexes. Secondly, solicited 20

experts' opinions to refine the construct indexes. Finally, used the FDT to screen the student development construct indexes.

Stage Three (Evaluate student development level). This stage is the research's data analysis and student development evaluation component. It addressed research question 3. It completed the development of the student development survey instrument, which included the reliability and validity tests of the questionnaire, and assigned the index weight. Then, it described the sample selection and survey procedures and elaborated on the application of SPSS software to analyze the collected student development survey data. Finally, a detailed analysis of the overall student development level and the differences in the development of different groups of students is presented.

Stage Four (Countermeasures to improve student development). The stage is the application of data analysis results. It answered and solved research question 4. It verified the difference between the student development construct (expected student development goals) designed in stage 2 and the actual student development level (student evaluation results) evaluated in stage 3 and proposed countermeasures to improve the student development level.

3.2 Necessity Analysis of Student Development Construct Design

Chapter 1 clarified the existing problems and research significance of undergraduate vocational university student development. Chapter 2 elucidated the need for a developmental construct design for undergraduate vocational university students from a theoretical level through a literature elucidation review. This thesis also adopted the interview method further to illustrate its necessity in terms of practical needs.

Selection of interviewees. The interview method is a method of verbal communication in which the investigator speaks directly with the interviewee based on a survey outline to collect oral information (Brinkmann, 2014). The design of undergraduate vocational university student development construct involves policy makers, talent training goal makers, and students. Therefore, 42 persons in three categories were selected for interviewees in this thesis.

Design of interview content. Three different interview outlines were designed for this thesis to understand the various interpretations and understandings of student developmental construct from different perspectives of the interviewees. This thesis intended three interview outlines applicable to three types of interviewees: vocational education policymakers, talent training goal makers, and students at three levels: macro, meso, and micro.

Implementation of the interview. Based on the actual situation, the researcher used video interviews, face-to-face semi-structured interviews, and focus group discussions to interview the three categories of interviewees. Finally, the critical information collected from the analysis of the interviewees was analyzed to determine the necessary construct design for student development in undergraduate vocational universities.

3.3 Design of Student Development Construct

The student development construct (expected student development goals) is the knowledge, ability, and quality students need to have for graduation. The design goal is to clarify what abilities undergraduate vocational university students need to obtain upon graduation and design the construct that meets the requirements of student development based on related theories. This part mainly elaborates on the design basis, method, and steps of the undergraduate vocational university student development construct. The design basis of the student development construct: OBE theory, undergraduate vocational university talent training goal and specification, and student development research results. The design method of the construct: panel discussion, FDT, and survey method. The student development construct is designed in three steps: preliminary design, refinement, and determination of the student development construct.

3.3.1 Design Basis of Student Development Construct

The design of the undergraduate vocational university student development construct is based on OBE theory, undergraduate vocational university talent training goal and specification, and student development theory.

The theoretical basis of the research framework of this thesis is OBE theory. This thesis follows OBE theory's implementation principles and processes to derive the student development construct of undergraduate vocational universities. Focusing on development outcomes is the most fundamental principle of the OBE theory. Before implementing student development research, the researcher designed a blueprint for the student development construct and clarified the knowledge and ability construct that undergraduate vocational university students must have when they graduate. The design of the student development construct is the core part of this thesis.

Goals and specifications of talent training for undergraduate vocational education in China. The student development construct needs to meet the goals and specifications of talent training, which is the concretization of the demand for talent in a certain period of economic and social development. Therefore, the researcher summarized relevant literature on the positioning, goal, and

specification of undergraduate vocational university talent training in China's social and economic development context (Table 3.1 and Table 3.2).

Table 3.1: Relevant Research on the Positioning of Undergraduate Vocational University Talent Training in China's Social and Economic Development

Serial number	Title	Author	Year
a	The knowledge, ability, quality construct, and training of applied talents	Song et al.	2012
b	Research on the development of undergraduate vocational education in China	Ma	2015
c	Research on the positioning and training system of the critical ability of vocational education students in China under the new situation	Guo & Liu	2017
d	The foundation and practice of cohesive development between higher vocational colleges and applied universities	Liu et al.	2017
e	Training positioning, specifications, and system construction of high-quality applied talents	Li & Chang	2019
f	Research on talent training in undergraduate vocational education	Huang	2019

Table 3.2: Relevant Research on Talent Training Goal and Specification of China's Undergraduate Vocational Education

Serial number	Title	Author	Year
g	Research on the position of undergraduate vocational education talent training goal	Liu	2016
h	The talent training goal and practical problems of undergraduate vocational education	Fang	2019
i	A pilot study on China's undergraduate vocational education in the new era	Chen	2020
j	Survey on the status of undergraduate vocational education talent training	Wen & Yin	2020
k	Research on the standards and requirements of talent training of undergraduate vocational education in China	Hu	2020
l	Review of undergraduate vocational education research	Meng & Xu	2020
m	The direction, goal characteristics, and path of talent training in China's undergraduate vocational education	Wang & Huang	2020
n	The realistic dilemma, goal position and path breakthrough of undergraduate vocational education	Wang	2020

According to the above literature, scholars have divided undergraduate vocational university student training construct into knowledge, ability, and quality (Table 3.3).

Table 3.3: List of Undergraduate Vocational University Student Training Construct

Construct	Dimension	Project	Paper Basis
undergraduate vocational university student training construct	knowledge construct	general knowledge	a,b,d,e,f,g,h, i,j,l,m,n
		professional knowledge	a,b,d,e,f,g,h,i,j,k,l,m,n
	ability construct	general ability	a,b,c,d,e,f,g,h, i,j,k,l,m,n
		professional ability	a,b,c,d,e,f,g,h, i,j,k,l,m,n
		career development ability	a,b,c,d,f, i,j,k,l,m
	quality construct	personal quality	a,b,e,f,g,h,k,l,m,n
		professional quality	a,b,e,f,g,h,k,l,m,n

Table 3.4: Student Development Related Research

Serial number	Title	Author	Year
o	Investment in learning	Bowen	1993
p	Assessment for excellence: the philosophy and practice of assessment and evaluation in higher education	Astin	1993
q	Education and identity	Chickering	1993
r	Research on the development of college students influences factors based on the student participation theory participation	Zhao	2013
s	Research on student development based on learning gains	Guo	2014
t	Research on the influence of college students' extracurricular learning investment on student development	Wang	2014
u	College student development index: Construct and level-based on the analysis of 2016 CCSS survey data	Yang & He	2018
v	College student development index: Concept, construct, and key technology	Yang & He	2018
w	Research on the level, change track, and influencing factors of college student development Index-Based on CCSS survey data	He	2019
x	Research on the problems of diagnosis and improvement of the student development of vocational colleges	Zhuo	2019

Student development research. From the existing literature on student development research by experts and scholars (Table 3.4), it can be seen that

they identified roughly the same division of the dimensions of student development. Their interpretations of the specific dimensions and connotations of student development can be used as a reference for designing the student development construct of Chinese undergraduate vocational universities.

Table 3.5: Design Basic of Student Development Construct Indexes of Undergraduate Vocational Universities

Goal (1st-level index)	Element (2nd-level index)	Dimension (3rd-level index)	Factor (4th-level index)	Literature basis
student development	cognitive development	knowledge	general knowledge	a,b,d,e,f,g,h,i,j,l,m,n,o,p,r,s,t,u,v,w,x
			professional knowledge	a,b,d,e,f,g,h,i,j,k,l,m,n,o,p,r,s,t,u,v,w,x
		ability	general ability	a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x
			professional ability	a,b,c,d,e,f,g,h,i,j,k,l,m,n,r,s,t,u,v,x
			career development ability	a,b,c,d,f, i,j,k,l,m,x
	non-cognitive development	value	value	e,m,o,p,s,r,s,t,u,v,w
		quality	personal quality	a,b,e,f,g,h,k,l,m,n,o,p,q,r,s,t,u,v,w,x
			professional quality	a,b,e,f,g,h,k,l,m,n

The researcher concludes that the student development construct is divided into cognitive and non-cognitive development. Cognitive development includes knowledge and ability development; non-cognitive development includes value and other development (Astin, 1993; Guo, 2014; Yang & He, 2019). With the account of China's economic and social, and the requirements of undergraduate vocational university talent training goal on the quality dimension, this thesis concludes that the student development construct of

undergraduate vocational universities in China is divided into four dimensions: knowledge, ability, value, and quality (Table 3.5).

3.3.2 Design Method of Student Development Construct

The design method of student development construct. According to the relevant literature on the design method of construct indexes or evaluation indexes, it can be seen that the methods that scholars usually use are the interview method and the Delphi technique (Wang, 2019; Zhong, 2018). However, the interview method does not apply to this thesis. The reason is: the researcher had communicated with the lecturers and administrators of the three universities and was told that these colleges had just been upgraded to universities, and most of them are yet to have an unclear understanding of the talent training goal. Therefore, their understanding of undergraduate vocational education remains in college vocational education before the transition (Ren & Ding, 2020). Secondly, undergraduate vocational university student development is new, with little reference. There was no communication or learning between the interviewees during the interviews, and their answers may differ significantly, making it challenging to organize and summarize the interview results. If this thesis adopts the interview method to design the student development construct, it may be inaccurate and inconsistent with reality. The Delphi technique is an effective method to draw objective conclusions from the opinions of all parties. It is widely used to design various

evaluation index systems and determine specific indexes (Xu, 2008; Zhong, 2019). Therefore, the researcher used the Delphi technique to design the student development construct. The researcher consulted several rounds of experts in different fields (they may be familiar with undergraduate vocational university talent training goal and demand positioning, student development connotation or vocational education policy formulation, etc.) to design a scientific and reasonable construct that is in line with the actual undergraduate vocational university student development. The Delphi technique overcomes the problem that interviewees are unfamiliar with the research content and have no reference in the interview method. Delphi experts can indirectly communicate and learn from each other and give answers after in-depth thinking.

The design index system with the Fuzzy Delphi Technique is highly reliable. The Delphi technique results conclude repeated discussions and integration of opinions by multiple experts, which is reliable (Ocampo, 2018； Yao et al., 2022). However, to achieve convergence, experts often explain or even change their opinions based on the overall opinions in the previous round. If they do not make changes, these opinions may be excluded. This process can easily filter out valuable opinions, affecting expert consultation's value. Fuzzy Delphi law can use Fuzzy mathematical algorithms to consider this useful information and get the final expert opinions. In addition, the researcher

consulted 22 experts from six different fields, and their understanding of undergraduate vocational education student development may differ. Therefore, converging using the "traditional Delphi technique" expert opinions may be more challenging. It requires multiple rounds of consultation, which significantly increases the consultation cost, and some special expert opinions are often filtered out. However, the FDT requires only one consultation to express the experts' opinions more completely, effectively solving this problem (Padilla-Rivera, 2021). Therefore, this thesis adopted the FDT to design the student development construct.

The combination of Fuzzy mathematics and the traditional Delphi method was first proposed by Murray, who used Fuzzy mathematics theory to overcome the shortcomings of the conventional Delphi method. Subsequently, Ishikawa (1993), Zheng (2001), Lin (2009), Yang (2015), and others further improved and proposed the Fuzzy triangle algorithm and finally established the FDT. The practice has also proven that this method can reduce the number of consultations in the traditional Delphi method and accurately express the meaning of the indexes (Mustapha, 2022). In this thesis, the preliminary designed student development construct indexes were consulted by experts. Then, the researcher used the double-triangular Fuzzy number method to summarize and sort out expert opinions and used the "grey zone regular inspection method" to verify whether they have converged (Bouzon, 2016;

Yusof, 2021). After convergence, this researcher determined the final student development construct indexes.

3.3.3 Design Steps of Student Development Construct

This thesis uses FDT to design the student development construct of undergraduate vocational education, including three steps: first, preliminary design of student development construct indexes. To improve the scientificity of the student development construct designed in this thesis, a panel of experts (six experts) was invited to discuss and determine the preliminary design of the student development construct for undergraduate vocational education before conducting expert consultation. Second, the refinement of the student development construct indexes. The first round of expert questionnaire consultation was carried out, and 22 experts, based on the received materials, combined their knowledge and experience to give their opinions and suggestions on each index and explained the basis and reasons. The expert discussion group (six experts) discussed the experts' opinions and improved the indexes. Third, screening of the student development construct indexes. A second round of expert questionnaire consultation was conducted, in which the researcher consulted experts on the importance of construct indexes of student development, and the consultation data were summarized and counted using the fuzzy algorithm. The indexes below the threshold were deleted, and the student development construct indexes were finally filtered.

3.3.3.1 Preliminary Design of Construct Indexes

The researcher invited an expert discussion group (six experts) to preliminarily design the student development construct based on the draft designed by the researcher, relevant literature, and expert experience. The preliminary design includes three steps: selecting expert group members, designing the expert group discussion questionnaire, and determining the preliminary design of the undergraduate vocational education student development construct.

Selection of members of the expert group：

Experts in six fields: vocational education authorities, undergraduate vocational university, student development research, vocational student development planning, corporate human resources, and applied technical positions are familiar with undergraduate vocational education student development. Therefore, the researcher invited one expert in each field. A total of six experts (Table 3.6) were invited to review and discuss the researcher's preliminary summary of the student development construct 1st-level to 4th-level indexes. They discussed and designed the 5th-level indexes of the student development construct together. The 5th-level indexes are the test questions of the student development questionnaire, which are subordinate to the 4th-level indexes of the student development construct.

This thesis's expert definition standard is based on scholars' definitions of experts. They define experts based on their working years and professional titles (Zeng, 2005). First, experts need to have rich work experience. They are familiar with the talent training goals of undergraduate vocational education, the ability to construct high-quality tech talents, or student development. Secondly, they have at least a deputy senior professional title and have worked in the field for 10 years or more (Pan, 2007; Tian & Li, 2003; Zeng, 2015).

Table 3.6: Background of Expert Group Members for Preliminarily Designed the Student Development Construct

Name	Type	Title	Working years	The primary basis for selecting experts
Pre-Dp1	Human resource management expert	Human resource manager	≥10 years	1. Familiar with the talent needs of employers and match their positions. 2. Participated in more than 100 interviews for corporate talent recruitment.
Pre-Dp2	Undergraduate vocational education expert	Professor	≥10 years	1. Undertake the establishment of the college's talent training goal. 2. Published more than five journals related to undergraduate vocational education.
Pre-Dp3	Career development expert	Professor	≥10 years	1. Familiar with the career development of undergraduate vocational education students. 2. Guided development of vocational education students for more than eight years. 3. Won the honorary title of vocational education above the city hall level.
Pre-Dp4	Expert from vocational education authorities	Deputy director of the vocational education department	≥10 years	1. Participated in formulating and implementing vocational education policies for more than 20 years. 2. Clear about the talent training goal of undergraduate vocational education. 3. Won the honorary title of vocational education above the city hall level.
Pre-Dp5	Technical expert	Senior engineer	≥10 years	1. Know the specific ability construct of undergraduate vocational education talents. 2. Worked in applied talent positions for more than 10 years.
Pre-Dp6	Student development research expert	Professor	≥10 years	1. Familiar with the construct and dimensions of student development. 2. Published more than five journals related to student development.

In addition, it is essential to note in particular that the experts presented in Table 3.6 were invited only for the preliminary design of the undergraduate vocational education student development construct and to discuss the results of the Fuzzy Delphi expert consultation and were not included in the Fuzzy Delphi expert list.

The preliminary design of the questionnaire discussed by the expert group:

The specific content and implementation instructions of the expert group consultation are as follows:

Clarify the connotation and application of student development construct design. The researcher initially needs to clarify the following questions to the expert group. The core of the undergraduate vocational education student development construct and its indexes indicates the specific knowledge, ability, and quality students should possess after finishing their university education. The student development construct provides the basis for these universities to scientifically and objectively evaluate the student development level and point out the direction for these universities to improve the student development level.

Introduce the specific tasks that the expert group needs to complete. Based on the relevant literature, the researcher initially designed the "Expert consultation questionnaire (draft) for vocational university student development construct" (expert group consultation questionnaire). The researcher invited six experts to review and evaluate the 2nd-level- to 4th-level indexes of the student development construct and explore and analyze the 5th-level indexes. The experts summarized and formulated the undergraduate vocational education student development construct and its specific indexes.

The main questions for consultation with experts include the following aspects:

1. Can the 2nd-level to 4th-level indexes of the student development construct reflect the connotation of undergraduate vocational education student development?
2. Is the division of the construct and dimensions indexes of the student development construct reasonable and comprehensive?
3. Are there any ambiguities in the student development construct's 2nd-level- to 4th-level indexes? Is its word appropriate? What content of it needs to be improved? Does it need to add or delete content and indexes?
4. How many 5th-level indexes are included in each 4th-level index of the student development construct? What is the specific content of each

5th-level index?

5. What are the deficiencies in the design of expert consultation questionnaires (instructions, content presentation forms, filling instructions, etc.)?

Preliminary design of the student development construct:

The researcher compiled a preliminary designed construct indexes of student development based on the reference literature, combined with discussion, feedback, and suggestions for revision from the expert panel.

3.3.3.2 Refinement of Construct Indexes

This thesis conducted an expert consultation on the student development construct indexes preliminarily designed by the expert panel to refine the indexes further. This thesis collected experts' opinions on the construct indexes' modification, addition, and merging through the first round of expert consultation. Then, the researcher again invited the expert group (six experts) to discuss and improve the student development construct indexes.

Compilation of expert consultation questionnaire. According to the preliminary design of the undergraduate vocational education student development construct, the researcher compiled the "expert consultation questionnaire on student development construct (first round)".

Table 3.7: Background of Experts in Designing the Student Development Construct

Type	Title	Amount	Working years	The primary basis for selecting experts
Human resource management experts	Human resource management expert	4	≥10years	1. Familiar with the talent needs of employers and match their positions. 2. Participated in more than 100 interviews for corporate talent recruitment.
Undergraduate vocational education experts	Professor or associate professor	6	≥10years	1. Undertake the establishment of the college's talent training goal. 2. Published more than five journals related to undergraduate vocational education.
Career development experts	Professor or associate professor	2	≥10years	1. Familiar with the career development of undergraduate vocational education students. 2. Guided the development of vocational education students for more than eight years. 3. Won the honorary title of vocational education above the city hall level.
Experts from vocational education authorities	Head of the educational department	2	≥10years	1. Participated in formulating and implementing vocational education policies for more than 20 years. 2. Clear about the talent training goal of undergraduate vocational education. 3. Won the honorary title of vocational education above the city hall level.
Technical experts	Senior or sub-senior engineer	4	≥10years	1. Know the specific ability construct of undergraduate vocational education talents. 2. Worked in applied talent positions for more than 10 years.
Student development research experts	Professor or associate professor	4	≥10years	1. Familiar with the construct and dimensions of student development. 2. Published more than five journals related to student development.

Selection of the expert. The experts' selection mainly adopted the purposeful sampling method in this thesis. There are two conditions for the selection of experts. One is the professionalism requirement of the experts. They all have to be familiar with this research field. They are experts who set the talent training goal in undergraduate vocational universities, human resource managers who are familiar with the ability structure of talents, senior engineers who are engaged in applied talent positions, and experts who are

familiar with student development research or the formulation of vocational education policies. They have at least an associate professor title and have worked in the field for 10 years or more (Table 3.7). A total of 22 experts were selected for this thesis, 12 are university experts and scholars, and 10 are experts from vocational education authorities, human resources, and senior engineers.

The second is the expert authority coefficient requirement. The expert authority coefficient C_r is a criterion for identifying an expert's authority degree. The range C_r is between 0 and 1. In general, $C_r \geq 0.70$, it is regarded as an acceptable degree. $C_r = (C_a + C_s)/2$, C_r is determined by two factors: the basis of expert judgment and the coefficient of judgment basis. Second is the expert's familiarity with the problem C_s, the coefficient of familiarity. The closer C_r it is to 1, the higher the authority of the experts participating in the survey and the more reliable the expert consultation results are (Wu et al., 2014). The assignment of C_a and C_s is according to Table 3.8 and Table 3.9.

Table 3.8: Assignment of Coefficients for Expert Judgment Basis

Judgment basis	Degree of impact on expert judgment（C_a）		
	High impact	Fair impact	Low impact
practical experience	0.50	0.40	0.30
logical reasoning	0.30	0.20	0.10
knowledge of domestic and international	0.10	0.10	0.10
intuition	0.10	0.10	0.10
total	1.00	0.80	0.60

Source: Wu (2014)

Table 3.9: Assignment of Experts' Familiarity with Indexes

Familiarity	Coefficient（C_s）
very familiar	1.00
relatively familiar	0.75
generally familiar	0.50
not very familiar	0.25
very unfamiliar	0.00

Source: Wu (2014)

Expert survey implementation and data analysis. The researcher distributed the first round of questionnaires to 22 experts. Collected experts' familiarity, evaluation basis, and opinions with the indexes. The statistical analysis of the questionnaire consists of two parts. First, the expert authority coefficient. Second, student development construct index opinions. The researcher summarized the 22 expert authority coefficients and index opinions, then the six experts discussed and analyzed the indexes and refined the student development construct indexes.

3.3.3.3 Screening of Construct Indexes

This thesis used the FDT to screen the student development construct indexes. The researcher distributed the second round of questionnaires to experts who responded positively. Then the statistics and analysis experts gave "single value of importance" "minimum acceptable value of importance" and "maximum acceptable value of importance" for each index. This thesis used the double-triangle fuzzy number method to summarize and organize expert

opinions and the “grey zone regular inspection method” to verify whether the expert opinions reached convergence. In the case of an unconverted index, the process would continue until convergence is attained. This thesis deleted indexes, which importance is less than the threshold value, and determined the final student development construct indexes.

The consultation content of each index includes two parts: importance and acceptable range. In this context, “importance” indicates the significance of an index to another upper-level index and represents a single value of its importance. The acceptable range shows the maximum and minimum values of the degree of importance of this index to the upper-level index. The above values are integers between one and nine. The larger the value, the higher the degree of importance.

Establish a double triangular Fuzzy number:

Calculate the minimum D_L^i, maximum D_U^i, and geometric mean D_M^i in the “single value of importance” for each index i, and the minimum C_L^i, maximum C_U^i, and geometric mean C_M^i in the “minimum acceptable value of importance” the minimum O_L^i, the maximum O_U^i, and the geometric mean O_M^i. In the “maximum acceptable value of importance”. As a result, the Fuzzy triangular number $C^i = (C_L^i + C_M^i + C_U^i)$ of the “minimum acceptable value of importance” and the Fuzzy triangular number $O^i = (O_L^i + O_M^i + O_U^i)$ of the

"maximum acceptable value of importance" for each index i is established (Ocampo, 2018).

Test the convergence of expert opinions:

Test the grey zone. When $C_U^i \leq O_L^i$, there is no grey zone, meaning expert opinions are not convergent. The researcher needs to conduct the next round of questionnaire surveys with the current round of opinion statistics. When $C_U^i > O_L^i$, the two triangular fuzzy numbers overlap, and there is a grey zone. The researcher needs to calculate the grey zone test value to verify whether the expert opinion has reached convergence.

Calculate the grey zone test value. The grey zone $Z^i = C_U^i - O_L^i$ of the Fuzzy relationship is compared with the opinion range $M^i = O_M^i - C_M^i$ of the geometric mean of the "minimum acceptable value of importance" and the "maximum acceptable value of importance" to judge whether the expert opinions have reached convergence (Mustapha, 2022). If $M^i - Z^i > 0$, it indicates that the expert opinions have converged. If $M^i - Z^i < 0$, it means a Fuzzy zone with no consensus in expert opinions, and they do not converge. Also, it is necessary to send the geometric mean of the "minimum acceptable value of importance" and "maximum acceptable value of importance" of the indexes that have not reached convergence to the experts for reference and conduct the next round of questionnaire surveys until all indexes have reached

convergence. The consensus value G^i of the importance can be calculated.

Calculation of threshold value of screening indexes:

After several rounds of expert consultation and a grey area test, the evaluation opinions on the importance of each index finally reached convergence. Then, the researcher calculated the geometric mean according to the geometric mean of the "single value of importance" "minimum acceptable value of importance" and "maximum acceptable value of importance" of each index to obtain the consensus value G^i of the importance of each index. The larger the value of G^i, the higher the consensus and importance of the index. Then the geometric mean of the "single value of importance" "minimum acceptable value of importance" and the "maximum acceptable value of importance" of all indexes are calculated. This value is the threshold value T^i for index screening (Xie, 2012; Yang, 2016). When $G^i < T^i$, this index is deleted. Otherwise, it is reserved.

3.4 Student Development Evaluation

3.4.1 Development of Survey Instrument

The prerequisite and basis for conducting student development surveys are to develop a reliable student development survey instrument. This part concludes the design of the student development questionnaire, the reliability

and validity test of the questionnaire, and the determination of the weight of the student development construct indexes.

The development of the student development questionnaire. The student development questionnaire contains two parts: basic student information and student development evaluation. The primary student information includes basic personal information such as the university, grade, and gender of the surveyed student. The basis of the student development evaluation design is the student development construct designed by experts. What needs particular explanation is that this thesis assigns the 5-point Likert scale scores (*very much improved "5", a lot of improvement "4", general "3", slight improvement "2", almost no improvement"1"*) to the 5th-level index of student development construct to obtain the student development survey instrument.

3.4.2 Reliability and Validity Test

The reliability and validity of the questionnaire are the basis and guarantee of empirical research. After the questionnaire design is completed and before the questionnaire survey is carried out, the researcher will test and analyze the reliability and validity of the questionnaire

Reliability test of the questionnaire:

Reliability analysis is to analyze the reliability of the scale, which is an index that characterizes the degree of consistency of multiple measurement indexes to the same latent variable. Its basic concept is that if the results obtained in repeated experiments are relatively similar, the reliability of the results is higher. Conversely, reliability is considered low if the results are highly variable. Reliability analysis is applied to the reliability of the evaluation index system. When the reliability value is low, it indicates that the respondents have a great disagreement on the corresponding question, which means that the index involved in the question is unreliable and may need to be deleted.

On the contrary, when the reliability value is higher, the respondents have a more consistent opinion on the question. Commonly used reliability analysis methods include the KR20 method, split-half reliability coefficient method, and Cronbach's coefficient α. Among them, Cronbach's coefficient α is commonly used to measure reliability (Ramdan, 2019). The value of Cronbach's coefficient α is usually between 0 and 1. When its value is larger, the internal reliability of the research question is higher. Table 3.10 shows the standard for the value of Cronbach's coefficient α. When the coefficient value is less than 0.7, modifying or deleting the index system is usually necessary.

Table 3.10: Cronbach's Coefficient α Value Criterion

Cronbach coefficient α	Corresponding standard
$\alpha > 0.9$	very high reliability
$0.8 < \alpha < 0.9$	high reliability, credible
$0.7 < \alpha < 0.8$	reliability acceptable, credible
$0.6 < \alpha < 0.7$	credible and with a reference value, but the
$\alpha < 0.6$	need to redesign the scale

Validity test of the questionnaire：

After using the reliability analysis to test the internal consistency of the indexes, it is necessary to carry out the validity analysis of the questionnaire. Validity refers to the validity and correctness of the measurement index to the latent variable measurement, reflecting the measurement accuracy. The more consistent the measurement result is with the content to be measured or evaluated, the higher the validity, and conversely, the lower the validity of the measurement. Validity analysis can be performed using SPSS software. It mainly includes two methods: one is the KMO test, and the other is Barlett's sphericity test (Zhao, 2013).

Table 3.11: KMO Measurement Standard

KMO value	Measurement standard
$0.9 < \alpha < 1$	very good
$0.8 < \alpha < 0.9$	good
$0.7 < \alpha < 0.8$	acceptable
$0.6 < \alpha < 0.7$	basically accepted
$0.5 < \alpha < 0.6$	very poor
$\alpha < 0.5$	not suitable for factor analysis

Source：He（2019）

The KMO test is a factor analysis method used to analyze the correlation between indexes. The correlation between variables is weaker when the KMO value is close to 0. When the KMO value is close to 1, the correlation between variables is stronger. The KMO measurement standard is shown in Table 3.11.

Barlett's test of sphericity is a factor analysis method used to judge whether the variables are independent. The specific method tests whether the index correlation coefficient matrix is close to the unit matrix. The chi-square transformation of the correlation coefficient matrix obtains its statistics. When performing Barlett's test, when Bartlett's accompanying rate is less than 0.01, it indicates that the requirements are met.

3.4.3 Assignment of Weights to Construct Indexes

In calculating the student development index, each index has a different contribution to the previous level index. Therefore, the next level index weight must be considered when calculating the previous student development index. The next-level index weight directly affects the comprehensive evaluation results of the index. Changes in the weight value may cause a difference in the order of the evaluated objects. Scientifically determining the weight is the key to calculating the comprehensive development index. The weight is a relative structural number, a quantity that compares and weighs the relative importance of various factors in evaluating things (Dos Santos, 2019).

Currently, the commonly used weight determination methods include Analytic Hierarchy Process (AHP) method, the Delphi method, the Entropy method, and Fuzzy clustering analysis. The AHP method integrates expert experience and mathematical methods and calculates the system with more scientific qualitative and quantitative indexes. Its credibility is relatively high, and it can be calculated by related software, which can reduce the amount of calculation. Its logical process can be shown more clearly. The Delphi method also uses expert advice, but the number of indexes at the same level should not be too many. Otherwise, the weight distribution will be complex. The entropy value method can reflect the utility of the index information entropy value, so the reliability is higher than that of the AHP and Delphi methods. However, its constraints are that it needs sample data support and lacks comparisons between indexes. The fuzzy clustering analysis method can be used to classify the importance of fuzzy indexes. Still, it cannot calculate the specific weight of each index, which is more suitable for a situation where many indexes are at the same level.

Considering that the expert sample data of the student development construct index system is less, it contains more qualitative indexes. Therefore, this thesis adopted the AHP method, which combined the opinions of 22 experts in the third round of the expert questionnaire survey and the scientific calculation method to calculate the importance weight of each index.

a. Principles of analytic hierarchy process

When analyzing a problem with AHP, the first step is to stratify the problem. According to the nature of the problem and the overall goal, the problem is decomposed into different constituent indexes. According to the interrelated influence and affiliation between the indexes, the indexes are aggregated and combined at different levels to form a multi-level analysis construct. Each level has several indexes, and the relative importance of indexes in each level is judged by pairwise comparison, thereby judging the relative weight value of each index to the previous level. Ultimately this boils down to determining the relative importance of the lowest level relative to the highest level or the relative order of priority.

b. Steps of analytic hierarchy process

The main steps of the AHP method are divided into four main steps:

First, establish a hierarchical construct of problem analysis;

Second, construct a judgment (pairwise comparison) matrix;

Third, determination of index weights: it contains computing eigenvectors and consistency test;

Fourth, making decisions.

Step 1: Establish a hierarchical construct

A good recursive hierarchy construct is significant for problem-solving. A

recursive hierarchy is a construct in which complex things are broken down into components called indexes or factors. The indexes in the construct are grouped according to their respective attributes to form different levels. The previous level and act govern the indexes of the same level as guidelines for some indexes of the next level. The establishment of the hierarchical construct also means the establishment of the affiliation between the indexes. The number of levels is related to the complexity of the problem and the level of detail required. Establishing the hierarchy means dividing the goal of the decision, the factors to be considered, and the object of the decision into the highest, middle, and lowest levels according to their interrelationship and creating a hierarchy figure (Figure 3.2).

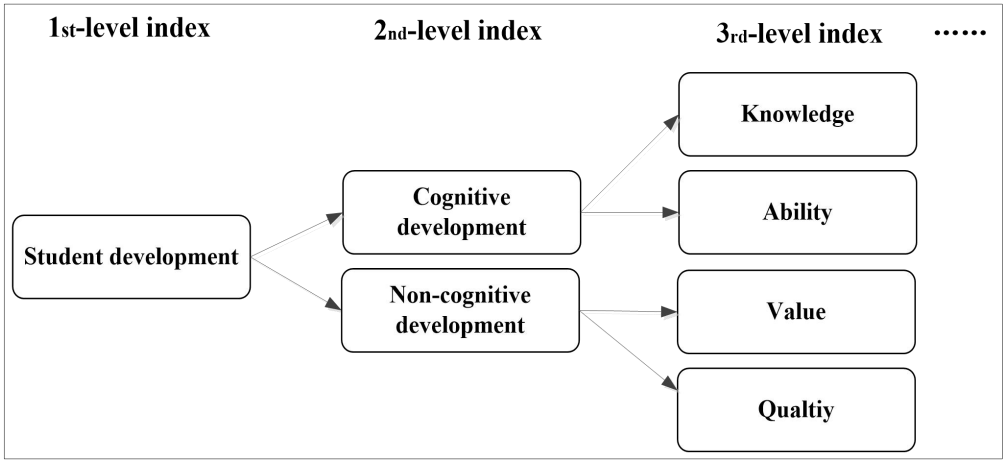

Figure 3.2: Recursive Hierarchy Construct

Step 2: Construct judgment (pairwise comparison) matrix

The indexes of the same upper-level index are judged in a two-by-two

comparison to arrive at a comparative value of relative importance, from which a judgment matrix is constructed.

In the AHP, to quantify the judgment and form a judgment matrix of the above values, the judgment is often quantified according to a certain ratio scale, and the common method is the 1-9 scale method, as shown in Table 3.12. For those problems that only rely on expert experience to make judgments, using a 1-9 scale to make pairwise comparisons is a more effective method. This method was proposed by Santy, which requires experts to answer the questions repeatedly and finally determine the specific relative importance judgment matrix. This method has a particular scientific nature.

On the one hand, in practical applications, to make qualitative distinctions effective and meet specific accuracy requirements, the objects to be compared must have the same quantity level or are relatively close to the same level of magnitude. After scientific investigation, the Santy scale is sufficient to express various properties of objects that cause people to perceive differences. On the other hand, the Santy scale has been proven by psychological experiments that it can reflect the judgment ability of most people because most people’s ability to distinguish the difference of the same attribute of different objects is between the Santy level.

Table 3.12: Scale Assignment and Interpretation

Value	Value meaning
1	Two indexes have the same importance.
3	One index is slightly more important than the other.
5	One index is significantly more important than the other.
7	One index is hugely more important than the other.
9	One index is enormously more important than the other.
2, 4, 6, 8	The median of the above two adjacent judgments
Derivative	Judgment C_{ij} by comparing index i with j, then judgment $C_{ji} = 1/C_{ij}$ by comparing index j with i

Source: Yang (2016)

After the hierarchical construct is established, the relative importance of each index level needs to be judged and assigned according to the scale. The method of assigning relative importance between two indexes can be provided by experts directly, completed through consultation with experts, obtained by analysts through some technical consultation, or determined through other channels. Generally, experts familiar with the field should give the judgment matrix independently. In this thesis, the assignment of the judgment matrix for the indexes at all levels of the undergraduate vocational education student development construct was determined by repeated consultation with senior experts.

Take the importance judgment matrix of 2nd-level indexes relative to 3rd-level indexes as an example. Generally speaking, for the 2nd-level index B_k, by comparing each of the 3rd-level indexes related to it (represented by C), the relative importance of the indexers C_i and C_j to the upper-level index

B_k constitutes a judgment matrix. For the n indexers, we obtain a pairwise comparison judgment matrix $C = (C_{ij})_{nxn}$, in the form of Table 3.13.

Table 3.13: Judgment Matrix

B_k	C_1	C_2	……	C_n
C_1	G_{11}	G_{12}	……	G_{1n}
C_2	G_{21}	G_{22}	……	G_{2n}
……	……	……	……	……
C_n	G_{n1}	G_{n2}	……	G_{nn}

Step 3: Calculate the feature vector (weight) and test the consistency

Calculate the product M_i of the indexes of each row of the judgment matrix：

$$M_i = \prod_{j=1}^{n} C_{ij}$$

Compute the nth root W_i of M_i:

$$W_i = \sqrt[n]{M_i}$$

Normalize $W_i = [W_1, W_2, ..., W_n]^T$:

$$W_i^{'} = \frac{W_i}{\sum_{j=1}^{n} W_j}$$

Then $W_i^{'} = [W_1^{'}, W_2^{'}, ..., W_n^{'}]^T$ is the desired eigenvector, that is, the weight of C_i.

Calculate the max eigenvalue λ_{max} of the judgment matrix:

The methods for calculating the max eigenvalue include the eigenvalue, sum, root, and episodic methods. This thesis adopted the root method.

$\lambda_{\max} = \sum_{i=1}^{n} \frac{(\mathrm{CW})_i}{\mathrm{nW}_i}$, where $(\mathrm{CW})_\mathrm{i}$ represents the ith index of CW.

The purpose of calculating the max eigenvalue of the judgment matrix is to check the consistency of the judgment matrix. Logically speaking, if C_1 is "important" than C_2, and C_2 is "important" than C_3, then C_1 should be "obviously more important" than C_3. Also, if C_1 is "important" than C_3, it is logically unreasonable. That is, the judgment matrix violates the consistency principle. For this reason, it is necessary to carry out a consistency test to ensure that the judgment matrix is logically reasonable and to lay a foundation for the subsequent analysis.

Calculate the consistency index CI:

$\mathrm{CI}=\frac{\lambda_{\max}-\mathrm{n}}{\mathrm{n}-1}$, where $\lambda_{\max}$ is the max eigenvalue of the judgment matrix, and n is the order of the comparison matrix.

$\mathrm{CI} = 0$, there is complete consistency;

CI is close to 0, with satisfactory consistency;

The larger the CI, the more severe the inconsistency.

When the order n exceeds 2, the random consistency index RI is introduced to measure the CI's size. The value is shown in Table 3.14, and n represents the order of the matrix.

Table 3.14: Random Consistency Index RI Value Table

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: Yang (2016)

The ratio of the consistency index CI of the judgment matrix to the random consistency index RI of the same order is called the random consistency ratio CR. Calculate the consistency ratio CR:

$$CR=CI/RI$$

When $CR<0.10$, it is considered that the degree of inconsistency of the judgment matrix C is within the allowable range. It has satisfactory consistency. It passes the consistency test, and its normalized eigenvector can be used as the weight vector. Otherwise, the judgment matrix needs to be adjusted.

Step 4: Calculation of index weight value

The researcher distributed the index weight questionnaire to experts, and they compared and scored the importance of indexes at all levels. Then analyzed the data, built its judgment matrix, and performed consistency test and weighted value calculation. In cases when indexes passed the consistency test, calculated the average of each expert's index weight values to obtain each index's weight value.

3.4.4 Methods of Student Development Evaluation

Student development evaluation contains three parts: sample selection, survey procedure, and data analysis.

a. Sample selection

This current thesis selected students from three undergraduate vocational universities in Shandong Province as the survey samples. They are chosen because the Chinese Ministry of Education regards Shandong undergraduate vocational education as a model of vocational education in China (MOE, 2019). It advocates using Shandong Province as a pilot project to explore undergraduate vocational education development. Shandong vocational education is at the forefront of China's vocational education development. Also, it is at the forefront of vocational education development research. The Chinese MOE advocates that Shandong Province's good practice of developing undergraduate vocational education can be promoted throughout China. At present, there are three undergraduate vocational universities in Shandong Province. Therefore, this current study recruited sample from these three universities as the survey samples.

This study adopts stratified sampling method to select the sample. It has the following advantages: 1. It improves the representativeness of the sample and hence the accuracy of inferring the totality of the population from the

sample. 2. It is particularly suitable for situations where inferences are to be made about the parameters of the totality as well as those of the sub-totals. 3. It is flexible and easy to implement and it is also easy to organize. The purpose of conducting student development evaluation in this study is to measure the overall development level of students in the three universities and also to analyze and compare different genders, subjects, grades, and universities, and the stratified sampling method can satisfy the investigative purpose of this study.

Before implementing the student development survey, the researcher obtained survey approval from three universities (Annexes A, B, and C) and survey support from Universiti Tunku Abdul Rahman (Annex D). Each undergraduate vocational university has an enrollment size of approximately 2,000 undergraduate students. In order for the sample to reflect the actual situation of the respondents, 1/5 of the total number of students (400 students) was selected as the respondents for this study. However, considering the validity of the questionnaire and the participation rate of the survey respondents, the researcher finally decided to sample 80 more students per university, totaling 480 students. To ensure the representativeness of the sample, the study conducted stratified sampling with four grades. In each university, 120 students of different genders were sampled in each of the 4 grades in the

arts and sciences faculties as a survey sample, for a total of 1,440 students in the three universities.

b. Survey procedure

This thesis aims to understand the undergraduate vocational education student development level through the survey. Therefore, it conducted a survey of students of different grades in three universities at the same time, which is a cross-sectional survey. Cross-sectional surveys collect data from selected subsets to simultaneously make inferences about the target population (Hall, 2008). The reliability and validity of the questionnaire and the evaluation of student development were surveyed through the "Questionnaire Star" online platform.

c. Calculation method of student development index level

The College Student Development Index (CSDI) was used to evaluate the student development level. There are qualitative and quantitative evaluation methods for non-cognitive ability evaluation of student development. The qualitative evaluation method mainly relies on the subjective evaluation of different subjects, such as counselors and teachers (Guo, 2021). The quantitative evaluation began in 2007 in a questionnaire survey of college student development in China, and scholars' quantitative evaluation mainly adopted the traditional hundred-point evaluation method (Guo, 2014). Later,

some scholars proposed the evaluation method of the CSDI (He, 2019; Yang, 2018), which can make the evaluation results more precise and intuitive. Therefore, this thesis used the CSDI to quantitatively evaluate the student development level.

Definition of CSDI. The CSDI foundation is the connotation requirement for college student development. It selects key indexes that can reflect college student development in multiple dimensions, such as knowledge and ability, and quantify the college student development index. The CSDI adopts a scoring method based on a hundred-point system. Each index's maximum and minimum standards calculated and synthesized by it are 5 and 1. According to the formula [(actual value-minimum value)/(maximum value-minimum value)], the individual test index score is transformed into an index form with a value between 0-1 to form a development index of a single index. The size of the index represents the student development level. The closer it is to 1, the higher the student development level. The closer it is to 0, the lower the student development level.

This thesis uses the CSDI to evaluate the student development level has important practical significance. On the one hand, it comprehensively evaluates the student development level and provides detailed data for horizontal comparison. CSDI can quantify the student development level by the relative

number of the 5 level indexes of the student development construct so that the student development level can be reflected through the index. Also, it can compare students' development level in different dimensions and groups of students. On the other hand, mastering the various elements of student development can provide a reference for colleges and universities to explore the problems. The CSDI is a relative number that is a comprehensive composite of multi-dimensional indexes. In terms of connotation, it includes knowledge, ability, and quality. The CSDI can be used to explain further the specific development of student knowledge and ability. Colleges and universities can find problems in student development based on these conditions.

According to the calculation formula and weight of the student development index, this thesis used SPSS (version 25) to analyze the student development index by stratification and classification (Chapter 4). It analyzed the level and variability of the student development index at different levels and dimensions. It also analyzed the developmental index of different groups: first-year students to seniors, females, and males, and students from different universities.

3.5 Recommendations for Improving Student Development

The student development construct (ideal student development goals) is established in this thesis, and the actual student development level is evaluated by applying an empirical survey study, which allows for the identification of shortcomings in student development through a longitudinal comparison of the differences that exist between ideal and real student development. In addition, the student development evaluation analyzes the differences between different levels, groups, and indicators. Through intra-student cross-sectional comparisons, student development characteristics and specific problems can be identified. Based on the problems found in the above horizontal and vertical comparisons, this thesis proposes targeted suggestions and measures to solve the problems (Chapter 5) to help education departments and universities work together to promote overall student development.

3.6 Chapter Summary

This chapter describes the research design of this thesis. First, it introduces the need to apply the interview method to determine the design of the student development construct. Then, it describes the rationale, methods, and steps of the student development construct design. The steps are described in detail: initial design, refinement, application of FDT screening, and identification of student development construct indexes. Then, it describes the reliability and validity testing methods of the questionnaire, elaborates on the

steps of applying the AHP method to determine the index weight, and analyzes the methods of student development evaluation and data analysis. Finally, the basis and methods for improving student development recommendations are clarified.

CHAPTER 4

RESEARCH NECESSITY AND DESIGN RESULTS OF STUDENT DEVELOPMENT CONSTRUCT

The literature review in Chapter 2 clarified that undergraduate vocational education student development was a research gap in the academic community from a theoretical level. This chapter demonstrates the necessity for this thesis at the practical level through the interview method and details the steps and results of the student development construct design.

4.1 Necessity Results of Student Development Construct Design

4.1.1 Selection of the Interviewees

Therefore, this thesis selected these three types of people (42 interviewees) as interview subjects (Table 4.1). The researcher interviewed three vocational education policymakers (they have been engaged in vocational education policy formulation for 10 years or more) and nine vocational university talent training goal makers (three people from each university, they have been engaged in vocational education work and research for 10 years or more), and 30 students (10 students in each university, five students in each first grade and second grade).

4.1.2 Design of the Interview Content

Three interview outlines corresponding to the three types of interviewees were designed for this thesis. Each of the three types of interview outlines has different concerns according to the perspectives of the different interviewees involved in viewing the issues, which are described as follows:

Interview outline for vocational education policymakers (Appendix E). The interviews aimed to understand the current status of China's talent construct, the policies adopted to promote the development of vocational education in China, and the monitoring and evaluation of the student development level from a macro level, from the perspective of vocational education policymakers.

The outline of the interview with the talent training goal makers of undergraduate vocational universities (Appendix F). The purpose of the interview is to understand the university's definition of high-quality tech talents, the matching of the training program with the talent training goals, the evaluation and tracking of training quality, and the evaluation of student development level from the meso level, from the perspective of the talent training goal makers.

Outline of the interview with students in undergraduate vocational universities (Appendix G). The interview aims to understand the basic information, attendance, career planning, and student development evaluation from the perimeter level, from the student's perspective.

4.1.3 Implementation of the Interview and Focus Group

Table 4.1: List of Interview Information

Type	Subject	Identity	Date	Location	Method	Outline	Duration
Vocational education policymakers	Policy maker 1	Deputy director of education bureau in charge of vocational education	May 9	Education bureau office	Semi-structured face-to-face interview	Interview outline for vocational education policy-makers	30 minutes
	Policymaker 2, 3	The staff of the vocational education section, the education bureau	May 10		Focus group		25 minutes
The talent training goal makers	Dean 1, 2	Member of the university talent target committee	May 12	Teacher's office of university1	Focus group	Outline of the interview with talent training goal makers	20 minutes
	Dean 3		May 13		Semi-structured face-to-face interview		25 minutes
	Dean 4,5,6		May 16	Teacher's office of university2	Focus group		30 minutes
	Dean 7		June 6	Tencent meeting app	Semi-structured video interview		20 minutes
	Dean 8,9		June 10	Teacher's office of university3			25 minutes
Students	Student 1-10	Student	May 12	Classroom of university1	Focus group	Student interview outline	20 minutes
	Student1 1-20		May 16	Classroom of university2			20 minutes
	Student 21-30		June 10	Classroom of university3			20 minutes

4.1.4 Analysis of Interview Results

The researcher compiled information from the three types of interviewees to summarize results directly related to the necessity for a student developmental construct design in undergraduate vocational universities (Table 4.2).

Based on the data from the interview results in the table 4.2, this section provides a detailed analysis of the necessity and importance of designing a development construct for undergraduate vocational education students from different perspectives.

Table 4.2: Results of Interviews on the Necessity for Student Development Construct Design

Interviewees	Item	Results	Percentage	Examples
Vocational education policymaker	Do the education department's policies contain elements to promote student development?	Yes	100.00%	PM1, 2: Policies on talent training goals, graduation standards, etc. PM3: In terms of talent training and curriculum.
		No	0.00%	
	Does the education department have a monitoring and evaluation system for student development quality?	Yes	100.00%	PM2, 3: Yes, but with a single approach to monitoring and evaluation. PM1: Fewer methods of evaluation and with a lag.
		No	0.00%	
	Do you think using the student development construct to evaluate the student development level is effective?	No	100.00%	PM1: Effective. PM 2, 3: Effective, but the construct has to be scientific and relevant.
		No	0.00%	
	If the student development construct is effective, are you willing to consider introducing the evaluation mechanism of it in the formulation of the policy?	Yes	100.00%	PM1, 2, 3: Willing to introduce effective student development construct into student development evaluation mechanisms to promote student development.
		No	0.00%	
Undergraduate vocational education talent training goal maker	Whether or not a survey has been done on the demand for talent in the industry?	Yes	33.33%	Dean1, 2, 7: Have researched and tracked the talent demand of the industry.
		No	66.67%	Dean3,4,8,9: We have understood the industry's talent demand but have not conducted long-term targeted surveys and tracking.

Table 4.2 continue next page

Interviewees	Item	Results	Percentage	Examples
Undergraduate vocational education talent training goal maker	Whether the university's talent training quality can meet the industry's talent requirements?	Slightly inadequate	22.22%	Dean1, 7: The talent cultivation qualitative has been improved, but there is still a slight shortage of matching industry talent requirements.
		Meet some of the requirements	11.11%	Dean9: Some of the qualities and abilities of graduates meet the requirements of enterprises, but some of them do not, such as practical ability and job adaptability.
		There is a certain gap	55.56%	Dean2, 3, 4, 6, 8: There is still a gap between the talent cultivation quality and the industry's requirements for the abilities and qualities of undergraduate vocational students.
		Does not meet	11.11%	Dean5:The ability structure of graduates cannot meet the requirements of enterprises for application-oriented talents.
	Are there any inadequate aspects of the university's talent cultivation goals?	Yes	100.00%	Dean4,6,8:Not enough practical requirements for students.Dean2:The requirement of professional knowledge for students is not deep enough. Dean1,3,5,7,9:The training program does not match the needs of the industry and has a lag.
		No		
	Has the university done any assessment and survey of student development?	Yes	44.44%	Dean1,4,7,9:Yes, but it is not comprehensive and systematic and only reflects the problems of some students' development.
		No	55.56%	Dean2,3,5,6,8:: The level of student development lacks scientific and practical assessment.
	If so, what methods were used?	Examinations or comprehensive assessments	44.44%	Dean1,4,7,9: The student developmental level is understood through course exams and comprehensive assessments.

Table 4.2 continue next page

Interviewees	Item	Results	Percentage	Examples
Undergraduate vocational education talent training goal maker	If so, what methods were used?	No	55.56%	Dean2,3,5,6,8: There are no valid methods of assessing student development.
	Which approach would you prefer to take to understand student development?	Questionnaire	11.11%	Dean8: Assessment scales are acceptable. However, there is more concern about the accuracy of the results.
		Software	33.33%	Dean2.6,7: It would be best if assessment software were available to make it easier and more efficient.
		Valid methods are acceptable	55.56%	Dean1,3,4,5,9: Either method is acceptable if the tool is valid and the results are reliable. The university is more concerned about the effectiveness of evaluation results in guiding practice.
	If the authors' student development assessment tool has been validated, would you be willing to use it at your university?	Yes	100.00%	They all expressed their willingness to use practical student evaluation tools that can help promote universities to cultivate talents that meet the needs of the industry.
		No	0.00%	
Undergraduate vocational university students	Do you have a clear plan for your future career development?	Yes	16.67%	Three students plan to enter graduate university and learn more before getting a job. Two students: prepare to enter an internship in a company early to learn more practical skills for the position and to lay a good foundation for finding a job in the future.
		No	83.33%%	25 students: 11 students think it's too early to graduate from the first or second year, so they don't have much planning for the future. 14 students: follow the university study schedule and do career planning in their junior or senior year.
	Does your university have other evaluation methods besides exams?	Yes	100.00%	30 students: There are other evaluation methods besides exams.
		No	0.00%	

Table 4.2 continue next page

Interviewees	Item	Results	Percentage	Examples
Undergraduate vocational university students	If so, what areas are covered?	Yes	100.00%	30 students: Inspection, daily performance, comprehensive assessment, etc.
		No	0.00%	
	Do you want to know what abilities undergraduate vocational university students should have and what your current development level is?	Yes	100.00%	31 students: Very interested in learning.
		No	0.00%	

Three aspects of information can be obtained from interviews with vocational education policymakers.

The current status of China's talent structure (question 1, 2, and 3). 100% of interviewees believe that China's current talent construct cannot meet the needs of economic and social development. There is a huge talent gap for high-quality tech talents. In particular, undergraduate vocational universities are in their infancy. The number of high-quality tech talents they have trained is relatively small, which cannot meet China's demand for high-quality tech talents.

China's current policy orientation (question 4, 5, 6, and 7). 100% of the interviewees believe that China has adopted an active policy to promote the development of vocational universities. Two interviewees believe that China's speeding up the development of undergraduate vocational universities is an essential policy for solving problems. Among the measures taken, PM1 (Policy maker 1) believes that increasing the enrollment of undergraduate vocational universities will help solve the gap in the number of high-quality tech talents. PM2 thinks that improving the quality of talent training in undergraduate vocational universities will help solve the quality problem of high-quality tech talents. PM3 shows that increasing the funding and reputation of undergraduate vocational universities can increase the public's recognition of undergraduate

vocational universities. 100% of the interviewees indicate that attention should be paid to the student development level of undergraduate vocational universities. The current policy formulated by China is mainly to measure the quality of student development in terms of the talent training goal and graduation standard.

Monitoring and evaluation of the student development level (question 8 and 9). 100% of the interviewees indicated the current monitoring and evaluation methods for the student development level are single, and there is a lag in monitoring it. They believe using the scientific student development construct is adequate to evaluate the student development level. After the results of this thesis have been promoted and run in practice, the interviewees are willing to introduce the student development construct into the evaluation mechanism of student development.

The following three aspects can be learned in the interviews with those who make the talent training goal in undergraduate vocational universities.

The definition and application of high-quality tech talents (question 1, 2, and 3). The interviewees believe high-quality tech talents should include knowledge, ability, and quality requirements. The training and development of these aspects are reflected in the formulation of the talent training goal.

Evaluating and tracking talent training quality (questions 4, 5, and 6). The interviewees believe that the employment direction of the students is evident. However, Only 33.33% of interviewees have tracked the industry's talent needs but have not evaluated the quality of talent training. 44.44% of the interviewees conducted surveys on employers in the industry. The survey results showed that the newly recruited students could adapt to the job requirements within 8-15 months.

Evaluation of student development (question 7, 8, and 9). 100% of interviewees believe the university's talent training program has insufficient aspects. Dean 4,6,8 think that the practical requirements for students are not high. Dean2 claimed that the students' professional knowledge is not in-depth. Dean 1,3,5,7,9 believe that the training program does not match the needs of the industry and is relatively lagging. Five interviewees believe there is a lack of effective evaluation of the student development level. Interviewees generally believe that more attention should be paid to student development. They have a high degree of acceptance of evaluation methods. They think evaluation instruments, interviews, and systems are acceptable. However, they are more concerned about the accuracy of evaluation results and the effectiveness of guiding practice. All interviewees are interested in student development in this

thesis. They expressed confidence in the results' validity and willingness to use them.

In the interviews with undergraduate vocational university students, the following four areas of information could be obtained.

Basic student information (question 1 and 2). By understanding students' basic information, the researcher clearly understands the students' enrollment situation. Among the 30 students interviewed, 27 were admitted directly from high school, and three were admitted from vocational colleges.

Student attendance (question 3, 4, and 5). 70% of students are interested in the major they studied, 83.3% of students only have a simple and intuitive understanding of the counterpart employment industry of the major, and 16.67% of students had a better understanding of that. All students claimed their universities offer theoretical and practical courses. The universities have student clubs, and 26.67% of students have joined them. 63.33% of students think that the club is helpful to their studies, and 36.67% believe that the clubs are just for developing interest and not beneficial to their studies.

Student career planning (question 6 and 7). All universities have carried out professional internships and practical activities. 11 students submitted

practice reports to achieve internship evaluation, employers evaluated 18 students, and one did not conduct an internship evaluation. 10% of students have a clear plan for future career development, and only 6.67% have made corresponding career preparations.

Student development evaluation (question 8 and 9). The evaluation indexes for all students include examinations, inspections, and comprehensive quality appraisals. 100% of students expressed a strong desire to clearly understand what abilities undergraduate vocational university students should have and their current development level, which can guide them on what areas they should focus on next to improve their abilities and development, and lay a good foundation for finding a job or study in the future.

The results of the interviews indicated the importance and necessity of the design of student development construct in undergraduate vocational universities. It can provide a reference for vocational education departments to make relevant policies. It can point out the direction for developing undergraduate vocational universities to make talent training programs and provide a reference for further improving student development. It can also point out the direction for students to improve self-development.

4.2 Design of Student Development Construct Indexes

The design of the student development construct indexes consisted of three steps: preliminary design, refinement, and screening. The expert panel and the researcher completed the initial design of the student development construct indexes. The first round of expert surveys was conducted to collect expert opinions on modifying the indexes. Then the expert panel discussed refining the student development construct indexes. Run a second round of expert consultation to collect experts' scores on the indexes' importance and apply the FDT to screen the indexes to obtain the final student development construct indexes.

4.2.1 Results of the Preliminary Design of Indexes

The expert panel discussed and analyzed the draft of the student development construct researcher designed based on their own experience and literature base. The researcher systematically analyzed the feedback and suggestions of the expert group and combined relevant references to summarize and improve the indexes of undergraduate vocational education student development construct. Finally, this thesis determined the preliminary designed student development construct in Table 4.3.

Table 4.3: Preliminary Designed Undergraduate Vocational Education Student Development Construct

Goal (1st-level index)	Element (2nd-level index)	Dimension (3rd-level index)	Factor (4th-level index)	Program (5th-level index)
student development	cognitive development	knowledge development	general knowledge	extensive coverage of relevant learn about science learn about the humanities learn about art
			professional knowledge	professional basic knowledge deep professional theoretical professional technical application
		ability development	general ability	good oral presentation ability well-written expression ability foreign language application ability proficiency in the application of organizational leadership ability ability to cooperate effectively with self-learning ability
			professional ability	job adaptability post operation ability ability to solve problems on the job ability to innovate professional
			career development ability	career planning ability career changeability career mobility ability career advancement ability
	non-cognitive development	value development	value	establishment of value personal outlook on the world and understanding of the culture and self-awareness
		quality development	personal quality	personal character physical and mental health sense of responsibility
			professional quality	professional ethics competitive awareness reverse thinking craftsman spirit

4.2.2 Results of the Refinement of Indexes

Compilation of Delphi expert consultation questionnaire. According to the preliminary design of the undergraduate vocational education student development construct, the researcher compiled the "Expert consultation questionnaire on student development construct of undergraduate vocational

universities-refinement indexes (first round)" (Appendix G). The construct of the questionnaire mainly includes six parts. The instruction part briefly explains the critical concepts involved in this consultation and the basis for compiling the questionnaire. It explains the purpose of this consultation and the importance of answering questions from the consultants. The instructions for completing the questionnaire section define the scope of this thesis and the correct way to fill out the questionnaire. The introductory information section requires personal information, such as the age of the expert. The judgment basis section mainly contains the expert's familiarity with the indexes and the factors influencing the judgment basis. The questions section primarily covers the modification, addition, and merging of indexes and the reasons for them. The concluding section thanks the expert and sends them best wishes.

Expert survey implementation. From April 10 to May 10, 2022, the researcher distributed the first round of questionnaires to 22 experts, and they put forward suggestions on "merge," "modify," "retain," or "add" for each index and explained the reasons (Appendix H).

The degree of positivity of the experts. The researcher distributed 22 questionnaires, returned 20, and the positive coefficient of experts was 91%. Among them, there were 20 valid questionnaires, and the effective rate of the questionnaires was 100%. It can be seen from the above data that, on the one

hand, experts' enthusiasm is high. Experts are more interested in designing and researching undergraduate vocational education student development construct indexes and could effectively answer the consultation questionnaire.

Table 4.4: Expert Authority Level

Expert number	Familiarity coefficient C_S	Judgment basis				Judgment basis C_a	Authority coefficient C_r
		Practical experience	Logical reasoning	Knowledge of domestic and international	Intuition		
1	0.75	0.50	0.30	0.10	0.10	1.00	0.88
2	1.00	0.50	0.30	0.10	0.10	1.00	1.00
3	0.75	0.50	0.20	0.10	0.10	0.90	0.83
4	0.50	0.40	0.30	0.10	0.10	0.90	0.70
5	0.75	0.50	0.20	0.10	0.10	0.90	0.83
6	0.75	0.50	0.30	0.10	0.10	1.00	0.88
7	1.00	0.50	0.20	0.10	0.10	0.90	0.95
8	1.00	0.50	0.30	0.10	0.10	1.00	1.00
9	0.75	0.50	0.30	0.10	0.10	1.00	0.88
10	0.75	0.50	0.30	0.10	0.10	1.00	0.88
11	1.00	0.50	0.30	0.10	0.10	1.00	1.00
12	0.75	0.50	0.30	0.10	0.10	1.00	0.88
13	0.75	0.40	0.30	0.10	0.10	0.90	0.83
14	1.00	0.50	0.30	0.10	0.10	1.00	1.00
15	1.00	0.50	0.30	0.10	0.10	1.00	1.00
16	0.75	0.50	0.20	0.10	0.10	0.90	0.83
17	1.00	0.50	0.30	0.10	0.10	1.00	1.00
18	0.75	0.50	0.30	0.10	0.10	1.00	0.88
19	1.00	0.50	0.30	0.10	0.10	1.00	1.00
20	0.75	0.50	0.20	0.10	0.10	0.90	0.83
Mean value	0.84	0.49	0.28	0.10	0.10	0.97	0.91

Analysis of expert authority coefficients using statistics. According to the first round of expert consultation questionnaires, the expert authority coefficient values distribution was calculated to be between 0.7 and 1.0, with a mean value of 0.91. It shows that the degree of authority of experts is high, and

the results of expert consultation are reliable. The authority coefficients of each expert are shown in Table 4.4.

Table 4.5: Results of the First Round of Expert Consultation

Indexes that need to be refined			
Original No.	**Index**	**Expert Suggestion**	**Handling Opinion**
C3	value development	Value is part of quality. It is recommended to combine value and quality.	To merge C3 with C4.
C4	quality development	Quality covers value. It is recommended to combine quality and value.	To merge C4 with C3.
E6	deep professional theoretical knowledge	Unlike regular undergraduate education, undergraduate vocational education focuses more on cultivating students' technical theory. Thus modifying it into deep professional theoretical knowledge is recommended.	Modify E6.
E12	organizational leadership ability	They are mainly engaged in technical skills work, and enterprises do not have high requirements for their organizational leadership. It is recommended to modify specific organizational leadership.	Modify E12.
Indexes that need to be added			
Original No.	**Indexes**	**Reasons for adding indexes**	**Handling Opinion**
E19	emergency handling ability	The students work in the production line, and in the early stage of an accident, they need good emergency handling ability, which can significantly reduce the damage of the accident.	In the vocational ability module, it is recommended to add the emergency handling ability.
E30	dialectical thinking	Unlike specialist vocational education students, undergraduates need to be able to think dialectically and view technical skills jobs with a developmental eye.	In the personal quality module, it is recommended to add dialectical thinking.
E34	legal awareness	They need to have strict legal awareness in their careers.	In the professional quality module, it is recommended to add legal awareness.

Table 4.6: Refinement of Student Development Construct Indexes in Undergraduate Vocational Education

Goal (1st-level index)	Element (2nd-level index)	Dimension (3rd-level index)	Factor (4th-level index)	Program (5th-level index)
student development (A)	cognitive development (B1)	knowledge development (C1)	general knowledge (D1)	extensive coverage of relevant fields of knowledge (E1)
				learn about science (E2)
				learn about the humanities (E3)
				learn about art (E4)
			professional knowledge (D2)	professional basic knowledge (E5)
				deep professional theoretical knowledge (E6)
				professional technical application knowledge (E7)
		ability development (C2)	general ability (D3)	good oral presentation ability (E8)
				well-written expression ability (E9)
				foreign language application ability (E10)
				proficiency in the application of information technology (E11)
				organizational leadership ability (E12)
				ability to cooperate effectively with others (E13)
				self-learning ability (E14)
			professional ability (D4)	job adaptability (E15)
				post operation ability (E16)
				ability to solve problems on the job (E17)
				ability to innovate professional positions (E18)
				emergency handling ability (E19)
			career development ability (D5)	career planning ability (E20)
				career changeability (E21)
				career mobility ability (E22)
				career advancement ability (E23)
	non-cognitive development (B2)	quality development (C3)	value (D6)	establishment of value (E24)
				personal outlook on the world and life (E25)
				understanding of the culture and values of different groups (E26)
			personal quality (D7)	self-awareness (E27)
				personal character (E28)
				physical and mental health (E29)
				sense of responsibility (E30)
				dialectical thinking (E31)
			professional quality (D8)	professional ethics (E32)
				competitive awareness (E33)
				reverse thinking (E34)
				craftsman spirit (E35)
				legal awareness (E36)

Statistical analysis of opinions on construct indexes of student development. After the statistical integration of 20 experts' opinions (Table 4.5) by six expert panelists, the original indexes with unclear definitions, mutual inclusion, or new ones were modified, merged, or added, and finally, two 2nd-level indexes, three 3rd-level indexes, eight 8th-level indexes, and 36 5th-level indexes were formulated, as shown in Table 4.6.

4.2.3 Results of Screening of Indexes

Index screening includes survey implementation, data analysis, and analysis of results.

a. Implementation of the survey

To screen for valid indexes, the researcher conducted a second round of expert survey questionnaires to experts from June 5 to July 5, 2022 (Appendix I). The survey subjects were effectively recovered from the first round of questionnaires. 20 questionnaires were distributed in this survey, 20 valid questionnaires were returned, and the recovery rate of useful questionnaires was 100%.

b. Data analysis

The researcher counted the valid questionnaires, followed the steps of FDT, and applied Microsoft Excel to process the data to calculate the

importance degree consensus value, and grey zone check value of each index. The results are shown in Table 4.7.

Table 4.7: Results of the Second Round of Expert Consultation

5th-level index	A grey area Z^i	Convergence test M^i	A grey area test value $M^i - Z^i$	Importance value G^i	Whether to converge
E1	2	1.55	-0.45	2.12	No
E2	1	2.10	1.10	7.70	
E3	0	2.20	2.20	7.72	
E4	1	2.50	1.50	7.67	
E5	1	2.05	1.05	7.65	
E6	1	2.25	1.25	7.93	
E7	1	2.25	1.25	7.93	
E9	1	2.00	1.00	7.70	
E10	-1	2.20	3.20	7.67	No
E11	1	2.25	1.25	7.82	
E12	1	2.05	1.05	7.70	
E13	2	2.05	0.05	7.92	
E14	1	2.15	1.15	8.05	
E15	1	2.20	1.20	7.95	
E16	1	2.00	1.00	8.03	
E17	1	2.05	1.05	8.15	
E18	1	2.10	1.10	7.83	
E19	1	2.15	1.15	7.97	
E20	1	2.25	1.25	7.75	
E21	1	2.20	1.20	7.72	
E22	1	2.00	1.00	8.02	
E23	1	1.95	0.95	7.87	
E24	1	1.85	0.85	8.28	
E25	1	2.05	1.05	8.15	
E26	1	2.15	1.15	7.70	
E27	1	2.05	1.05	8.07	
E28	1	1.95	0.95	8.20	
E29	1	2.05	1.05	8.20	
E30	1	2.00	1.00	8.23	
E31	-1	2.70	3.70	7.65	No
E32	1	2.10	1.10	8.18	
E33	-1	2.60	3.60	3.97	No
E34	4	6.45	2.45	4.42	
E35	1	2.60	1.60	7.70	
E36	1	2.20	1.20	8.03	

The importance evaluation of four indexes did not reach convergence (the marked grey part in Table 4.7). Next, the researcher sent the geometric mean of

the “acceptable minimum value of importance degree” and “maximum acceptable degree of importance degree” of the indexes that have not converged in this round of questionnaires to experts for reference and carried out the following questionnaire process.

Table 4.8: Screening of Student Development Construct Indexes in Undergraduate Vocational Education

5th-level index	A grey area Z^i	Convergence test M^i	A grey area test value $M^i - Z^i$	Importance value G^i	Processing
E1	1	1.60	0.60	2.12	Delete
E2	1	2.10	1.10	7.70	
E3	1	2.10	1.10	7.68	
E4	1	2.50	1.50	7.67	
E5	1	2.05	1.05	7.65	
E6	1	2.25	1.25	7.93	
E7	1	2.25	1.25	7.93	
E8	1	2.20	1.20	7.95	
E9	1	2.00	1.00	7.70	
E10	1	1.85	0.85	7.72	
E11	1	2.25	1.25	7.82	
E12	1	2.05	1.05	7.70	
E13	2	2.05	0.05	7.92	
E14	1	2.15	1.15	8.05	
E15	1	2.20	1.20	7.95	
E16	1	2.00	1.00	8.03	
E17	1	2.05	1.05	8.15	
E18	1	2.10	1.10	7.83	
E19	1	2.15	1.15	7.97	
E20	1	2.20	1.20	7.73	
E21	1	2.20	1.20	7.72	
E22	1	2.00	1.00	8.02	
E23	1	1.95	0.95	7.87	
E24	1	1.85	0.85	8.28	
E25	1	2.05	1.05	8.15	
E26	1	2.15	1.15	7.70	
E27	1	2.05	1.05	8.07	
E28	1	1.95	0.95	8.20	
E29	1	2.05	1.05	8.20	
E30	1	2.00	1.00	8.23	
E31	1	2.50	1.50	7.68	
E32	1	2.10	1.10	8.18	
E33	2	2.10	0.10	3.90	Delete
E34	4	5.90	1.90	4.23	Delete
E35	1	2.60	1.60	7.70	
E36	1	2.20	1.20	8.03	

Table 4.9: Confirmation of Student Development Construct Indexes Indexes in Undergraduate Vocational Education

Goal (1st-level index)	Element (2nd-level index)	Dimension (3rd-level index)	Factor (4th-level index)	Program (5th-level index)
student development (A)	cognitive development (B1)	knowledge development (C1)	general knowledge (D1)	learn about science (E1)
				learn about the humanities (E2)
				learn about art (E3)
			professional knowledge (D2)	professional basic knowledge (E4)
				deep professional theoretical knowledge (E5)
				professional technical application knowledge (E6)
		ability development (C2)	general ability (D3)	good oral presentation ability (E7)
				well-written expression ability (E8)
				foreign language application ability (E9)
				proficiency in the application of
				organizational leadership ability (E11)
				ability to cooperate effectively with
				self-learning ability (E13)
			professional ability (D4)	job adaptability (E14)
				post operation ability (E15)
				have the ability to solve problems on the job (E16)
				possess the ability to innovate professional positions (E17)
				emergency handling ability (E18)
			career development ability (D5)	career planning ability (E19)
				career changeability (E20)
				career mobility ability (E21)
				career advancement ability (E22)
	non-cognitive development (B2)	quality development (C3)	value (D6)	establishment of value (E23)
				personal outlook on the world and life (E24)
				understand the culture and values of different groups (E25)
			personal quality (D7)	self-awareness (E26)
				personal character (E27)
				physical and mental health (E28)
				sense of responsibility (E29)
				dialectical thinking (E30)
			professional quality (D8)	professional ethics (E31)
				craftsman spirit (E32)
				legal awareness (E33)

The second survey in the second time was conducted from July 8 to August 1. The subjects of this survey were the experts who had effectively returned from the previous two questionnaires. 20 questionnaires were distributed, 20 valid questionnaires were returned, and the return rate of valid questionnaires was 100%. Valid questionnaires were counted and processed with the FDT to calculate the importance consensus value of each index and the grey area test value. According to the calculation results, all indexes converged, and experts formed a consensus. As the calculated the threshold value $T^i = 7.54$ of the selected index, the researcher deleted the indexes which importance degree value G^i is lower than the threshold value T^i, and the final result is shown in Table 4.8.

Applied the FDT to finally select 33 indexes of the student development construct of undergraduate vocational universities, as shown in Table 4.9.

c. Results analysis

After the second round of the second survey and calculation analysis, the number of indexes was reduced from 36 to 33. From Table 4.9, it can be seen that the "importance degree value G^i" of all participating indexes is distributed between 2 and 8.5. There are 33 indexes with a score of 6 or above. The top five indexes are E24 Establishment of value (8.28), E30 sense of responsibility

(8.23), E28 personal character and E29 physical and mental health (8.20), E32 professional ethics (8.18), E25 personal world outlook and outlook on life and E17 can solve problems on the job (8.15). It can be seen that experts paid more attention to the cultivation of the quality and morality of undergraduate vocational education students. It is consistent with China's employment standard of "having both ability and political integrity, putting morality first" and "cultivating people with morality is the foundation of colleges and universities". It also reflects the characteristics of colleges and universities of socialism with Chinese characteristics. The least important is E1 extensive involvement in related knowledge fields, followed by E33 competitive awareness (3.90) and E34 reverse thinking (4.23). The above three indexes G^i do not exceed the threshold value T^i of all indexes, experts do not believe that extensive research in relevant knowledge fields, competitive awareness, and reverse thinking is the focus of undergraduate vocational education talent training.

4.3 Chapter Summary

This chapter analyzed the importance and necessity of student development research in undergraduate vocational universities by interviewing three types of personnel and analyzing interview data. A five-level student development construct was designed through three steps: preliminarily design, refinement, and application of the FDT to screen indexes.

CHAPTER 5

STUDENT DEVELOPMENT EVALUATION RESULTS AND RECOMMENDATIONS

This chapter evaluates true student development level and makes recommendations to improve it. Based on the student development construct designed in the previous chapter, a student development evaluation instrument was developed to evaluate the development level and characteristics of different groups of students. This thesis proposed targeted countermeasures for universities to improve student development based on the evaluation results.

5.1 Student Development Evaluation

Student development evaluation is divided into three parts: reliability and validity test of the questionnaire, weight assignment of construct indexes, and evaluation of the development level of different groups of students.

5.1.1 Reliability and Validity Test

This thesis conducted a questionnaire survey on student development in undergraduate vocational universities through the “Questionnaire Star” web-based survey research platform. The researcher sent a link to the questionnaire website and invited students to respond. A total of 360 online

questionnaires (120 per university, 30 per grade) were distributed, and 308 questionnaires were returned, of which 295 were valid, with an efficiency rate of 95.8%.

a. Reliability test

SPSS software was used to do reliability analysis for 5th-level indexes under each 4th-level indexes separately. The reliability analysis results were obtained by importing the questionnaire results, as shown in Table 5.1. The three columns in the table show the index, Cronbach's coefficient α, and the number of indexes included, respectively. It can be seen from the table that Cronbach's coefficient α corresponding to each index is greater than 0.7. Therefore, there is no need to modify the indexes under this factor.

Table 5.1: Results of Reliability Analysis

Index	Cronbach's Alpha	N of items
general knowledge	0.90	3
professional knowledge	0.94	3
general ability	0.97	7
professional ability	0.97	5
career development ability	0.97	4
value	0.94	3
personal quality	0.94	5
professional quality	0.93	3

b. Validity test

The results of the validity analysis of the 5th-level indexes under each 4th-level index are shown in Table 5.2. The KMO value corresponding to each

index is greater than 0.6, which is acceptable. The compatibility rate of Barlett's test of sphericity is 0.00 is much less than the threshold value of 0.01, so it satisfies the requirements of the validity analysis and meets the independence assumption. Therefore, all indexes passed the validity analysis.

Table 5.2: Results of Validity Analysis

Index	Validity analysis results		
general knowledge	KMO Measure of Samplin Adequacy.		0.74
	Barlett's Test of Sphericity	Approx. Chi-Square	602.82
		df	3
		Sig.	<.001
professional knowledge	KMO Measure of Samplin Adequacy.		0.74
	Barlett's Test of Sphericity	Approx. Chi-Square	835.23
		df	3
		Sig.	<.001
general ability	KMO Measure of Samplin Adequacy.		0.93
	Barlett's Test of Sphericity	Approx. Chi-Square	2124.37
		df	7
		Sig.	<.001
professional ability	KMO Measure of Samplin Adequacy.		0.89
	Barlett's Test of Sphericity	Approx. Chi-Square	2103.26
		df	5
		Sig.	<.001
career development ability	KMO Measure of Samplin Adequacy.		0.88
	Barlett's Test of Sphericity	Approx. Chi-Square	1681.08
		df	4
		Sig.	<.001
value	KMO Measure of Samplin Adequacy.		0.76
	Barlett's Test of Sphericity	Approx. Chi-Square	7610.90
		df	3
		Sig.	<.001
personal quality	KMO Measure of Samplin Adequacy.		0.90
	Barlett's Test of Sphericity	Approx. Chi-Square	1412.09
		df	5
		Sig.	<.001
professional quality	KMO Measure of Samplin Adequacy.		0.77
	Barlett's Test of Sphericity	Approx. Chi-Square	739.60
		df	3
		Sig.	<.001

To sum up, the reliability and validity of each 4th-level index of the questionnaire are tested. It shows that the student development survey designed in this thesis is reasonable and reliable and can be used in student development surveys.

5.1.2 Assignment of Weights to Indexes

Following the AHP analysis steps, this section determined the indexes' weight of the student development construct indexes at the 2nd-4th level. It analyzed the index weight value results to provide a basis for student development evaluation.

Step 1: Establish a hierarchical construct of student development indexes

Based on the screening research of student development construct indexes in the previous section, this thesis can establish a hierarchy of student development construct indexes containing five levels, as shown in Table 4.9.

Step 2: Construct the judgment matrix

Calculating the weight of the student development indexes of the more complex undergraduate vocational education should collect the questionnaire survey data of several experts. Expert consulting transforms profound knowledge and experience into useful information for decision making using a

two-by-two comparison of relevant indexes. In this thesis, each 5th-level index is equally crucial to the 4th-level index to which it belongs, and the weight of each 5th-level index is 1. Therefore, the weight questionnaire (the third round of expert questionnaires) contains only a two-by-two comparison within each level of indexes in the 2nd-4th levels. This thesis distributed the questionnaire (Appendix J) to 20 experts who positively responded in the first two rounds. This survey recovered 20 valid questionnaires; the effective questionnaire recovery rate was 100%. Based on the scores of the 20 experts, a judgment matrix of construct indexes of student development was constructed (as in Table 5.3 and Table 5.4).

Step 3: Calculate feature vectors and consistency test

This questionnaire on the determination of weight values had 15 experts' ratings to construct a matrix that could pass the consistency test with a rate of 75%, indicating a reasonable composition of experts. For the scores that have not passed the consistency test, this researcher provided feedback to the experts for a second scoring, and the matrix constructed by all experts has passed the consistency test.

According to the rating of "Expert 1", the second-order judgment matrices for the 1st-level index A, 2nd-level index B1, and 3rd-level index C1 were built, and the consistency index values, the eigenvectors W_i of B1, B2, C1, C2, D1,

D2, and the maximum eigenvalues $\lambda_{\max}$ of the weight vectors were calculated by SPSS, as shown in Table 5.3. Built the third-order judgment matrices of the 3rd-level indexes C1 and C2, and calculated the consistency index value, eigenvector W_i, and the maximum eigenvalue of the weight vector $\lambda_{\max}$, as shown in Table 5.4.

Table 5.3: Index A, B1, C1 Judgment Matrix

Index	Judgment Matrix			
	A	B1	B2	W_i
1st-level	B1	1	1/2	0.33
Index A	B2	2	1	0.67
	CR=0.00, the maximum feature value of the weight vector $\lambda_{\max} = 2.00$			
	B1	C1	C2	W_i
2nd-level	C1	1	2	0.67
Index B1	C2	1/2	1	0.33
	CR=0.00, the maximum feature value of the weight vector $\lambda_{\max} = 2.00$			
	C1	D1	D2	W_i
3rd- level	D1	1	1/2	0.33
Index C1	D2	2	1	0.67
	CR=0.00, the maximum feature value of the weight vector $\lambda_{\max} = 2.00$			

Table 5.4: Index C2, C3 Judgment Matrix

Index	Judgment Matrix				
	C2	D3	D4	D5	W_i
3rd-	D3	1	1/3	1/5	0.11
level	D4	3	1	1/2	0.31
Index C2	D5	5	2	1	0.58
	CR=0.00, the maximum feature value of the weight vector $\lambda_{\max} = 3.000$				
	C3	D6	D7	D8	W_i
	D6	1	2	2	0.50
3rd- level	D7	1/2	1	1	0.25
Index C3	D8	1/2	1	1	0.25
	CR=0.00, the maximum feature value of the weight vector $\lambda_{\max} = 3.00$				

From the above, it can be seen that each matrix consistency test is less than 0.1, and the results are reasonable and valid. The W_i calculated above is the relative weight of each index relative to the previous level index to which it belongs, also called local weight. For AHP, the experts' scores are used as important ranking data for the indexes, and what it needs is the relative size. To be more in line with conventional thinking in subsequent use and evaluation, the absolute weight of each index was obtained after scaling the relative weight values of each level index by summing them to 1. It also is the proportion of the index weight among the indexes at the same level relative to the overall weight of student development, and it is also called the global weight. It is shown in Table 5.5.

Table 5.5: Expert 1 Scores Weights of Student Development Construct Indexes in Undergraduate Vocational Education

1st-level index	2nd-level index	Weight	3rd-level index	Relative weight	Absolute weight	4th-level index	Relative weight	Absolute weight
student development（A）	cognitive development（B1）	0.33	knowledge development（C1）	0.67	0.33	general knowledge (D1)	0.33	0.11
						professional knowledge (D2)	0.67	0.22
			ability development（C2）	0.33	0.17	general ability (D3)	0.11	0.04
						professional ability (D4)	0.31	0.10
						career development ability (D5)	0.58	0.19
	non-cognitive development（B2）	0.67	quality development（C3）	1	0.50	value (D6)	0.50	0.17
						personal quality (D7)	0.25	0.08
						professional quality (D8)	0.25	0.08

Table 5.6: Summary of Weights of Student Development Construct Indexes in Undergraduate Vocational Education

1st-level index	2nd-level index	Weight	3rd-level index	Relative weight	Absolute weight	Order	4th-level index	Relative weight	Absolute weight	Order
student development（A）	cognitive development（B1）	0.50	knowledge development（C1）	0.33	0.17	3	general knowledge (D1)	0.37	0.06	7
							professional knowledge (D2)	0.63	0.10	6
			ability development（C2）	0.67	0.33	2	general ability (D3)	0.11	0.04	8
							professional ability (D4)	0.32	0.11	5
							career development ability (D5)	0.57	0.19	2
	non-cognitive development（B2）	0.50	quality development（C3）	1	0.50	1	value (D6)	0.47	0.24	1
							personal quality (D7)	0.28	0.14	3
							professional quality (D8)	0.25	0.16	4

Step 4: Determine the weight value of student development construct indexes

The researcher repeated the above method to calculate the scores of 20 experts in turn, and then used Microsoft Excel to perform a geometric weighted average of the weight values of all experts for a certain index, and then calculated the relative weight value of that index for the upper-level index (Appendix L). Next, according to the relative weight, the absolute weight of each index was calculated and sorted by index consistency. The results are shown in Table 5.6 above.

Analysis of index weight results. As seen in Table 5.6, the weight values in two 2nd-level indexes, three 3rd-level indexes, and eight 4th-level indexes are varied. It means the indexes are not equally important for undergraduate vocational education student development. The two 2nd-level indexes have approximately equal weight values, which indicates that cognitive and non-cognitive development are almost equally important for student development. The ranking of 3rd-level indexes shows that the most critical aspect of student development is quality development, competence development, and knowledge development. It is consistent with the expectation of this thesis and the essential characteristics of the socialist education theory with Chinese characteristics of moral education first, ability-oriented, and all-round development. The top five of the eight

4th-level indexes are value (D6), career development ability (D5), personal quality (D7), professional quality (D8), and professional ability (D4), which is basically in line with the order of importance in the index filtering.

5.1.3 Student Development Evaluation

This section describes the student development survey, development index calculation, and development evaluation result analysis.

(1) Student development survey

The researcher distributed student development web questionnaires (Appendix K) to 120 students in each grade in the three universities. 1440 questionnaires were distributed, and 1431 were returned. Then the questionnaires with missing data were deleted, and the valid questionnaires were 1422, with an effective rate of 99.4%.

Table 5.7: Statistical Information of Survey Respondents

Item	Category	No. of people	Percentage (%)
Gender	Male	615	43.25%
	Female	807	56.75%
Subject	Sciences	932	65.54%
	Arts	490	34.46%
Grade	First-grade students	394	27.71%
	Second-grade students	363	25.53%
	Third-grade students	366	25.74%
	Fourth-grade students	299	21.03%
University	University1	478	33.61%
	University2	450	31.65%
	University3	494	34.74%

This thesis focused on student differences by grade, gender, subject, and university. Therefore, the statistical characteristics of the number of students with specific background characteristics and their percentage data are described in this thesis in Table 5.7 below.

（2）Calculation of student development index

Based on the index weights and the collected survey data, this thesis used One-sample t-test, Independent-samples T-test, and One-way ANOVA test to analyze the student development index. Because of the prerequisites for the above test and analysis, this thesis conducted a normal distribution test and a homogeneity of variance test on the data and performed a nonparametric test on the individual ineligible data before the analysis.

a. Evaluating the overall development index level of students

Evaluating the overall development level of students helps universities understand the overall development level of students. This thesis first analyzed students' development level at each level and clarified the development level and differences between students in different dimensions.

1st-level student development index level:

The results of the test of the 1st-level development index for the entire sample of students in undergraduate vocational universities (Table 5.8) showed that the mean value of the 1st-level development index of students was 0.66,

which reached a moderately high level (higher than the theoretical median of 0.50). The results of the One-sample T-test showed significant differences (p<.001) in the 1st-level student development index, indicating substantial differences in development among individual students.

Table 5.8: 1st-Level Student Development Index Level

Level	Index name	Mean value	Standard deviation	Significance
1st-level index	student development (A)	0.66	0.12	<.001

2nd-level student development index level:

As shown in Table 5.9 and Figure 5.1, in the 2nd-level development index, the cognitive and non-cognitive development index values were 0.63 and 0.68, respectively, reaching an above-medium level. The mean and standard deviation of the non-cognitive development index were higher than that of the cognitive development index. The results of the independent-samples t-test showed a significant difference between the two indexes of cognitive and non-cognitive development (p<.001), which indicates the unevenness of the student development between the two indexes of cognitive and non-cognitive development.

Table 5.9: 2nd-Level Student Development Index Level

Level	Index name	Mean value	Standard deviation	Significance
2nd-level index	cognitive development (B1)	0.63	0.13	<.001
	non-cognitive development (B2)	0.68	0.19	

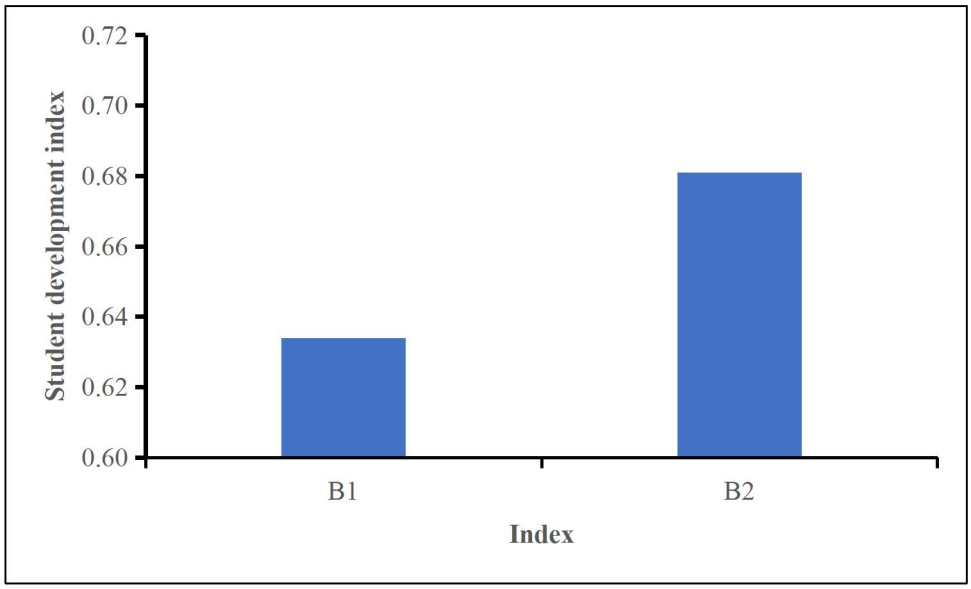

Figure 5.1: 2nd-Level Student Development Index

3rd-level student development index level:

As seen in Table 5.10 and Figure 5.2, the knowledge, ability, and quality development indexes were 0.64, 0.63, and 0.70, respectively, reaching an above-medium development level. Among the three 3rd-level indexes, the highest mean value of the quality development index (0.70) was followed by the knowledge development index (0.64), and the lowest was the ability development index (0.63). The results of the One-way ANOVA test showed the same significant difference between the three 3rd-level indexes (p<.001).

Multiple comparisons revealed (Table 5.11) that there was a difference between knowledge and ability development indexes (MC1=0.01, p=0.028) (MC is the difference between the two development indexes). Significant

differences were found between knowledge and quality development indexes (MC2=-0.06, p<.001) and ability and quality development indexes (MC3=-0.01, p<.001). The above results further indicate the unevenness of individual student knowledge, ability, and quality development.

Table 5.10: 3rd-Level Student Development Index Level

Level	Index name	Mean value	Standard deviation	Significance
3rd-level index	knowledge development (C1)	0.64	0.15	<.001
	ability development (C2)	0.63	0.14	
	quality development (C3)	0.70	0.16	

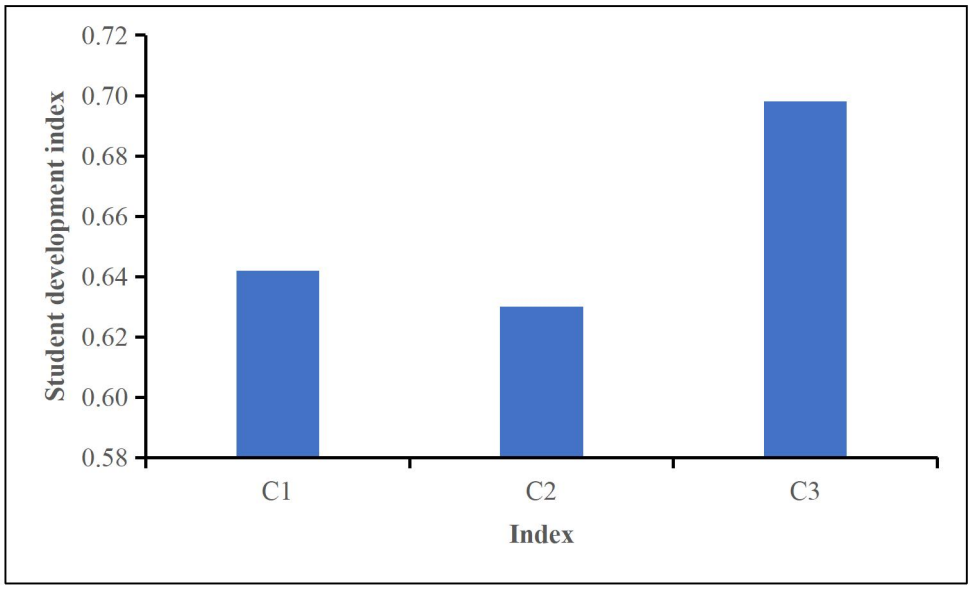

Figure5.2：3rd-Level Student Development Index

Table 5.11: Multiple Comparison Analysis of 3rd-Level Student Development Indexes

Control group	Comparison group	Mean difference	Significance
knowledge development	ability development	0.01	0.028
	quality development	-0.06	<.001
ability development	quality development	-0.01	<.001

4th-level student development index level:

Table 5.12 and Figure 5.3 shows that the eight 4th-level indexes of general knowledge, professional knowledge, general ability, professional ability, career development ability, value, personal quality, and professional quality development were 0.65, 0.64, 0.64, 0.63, 0.62, 0.71, 0.70, and 0.68, all of which also reached an above medium level of development. Among them, the highest mean value of the development index was value (0.71), followed by personal quality and professional quality (0.70), and the development index of career development ability was the lowest (0.62). The results of the One-way ANOVA test showed that the eight 4th-level indexes were also significantly different (p<.001).

Table 5.13's multiple comparisons showed no statistically significant difference between general and professional knowledge, general or professional ability (MD1=-0.00, p=1.000). Differences between knowledge and general ability (MD8=0.00, p=0.679) and professional ability (MD9=0.01, p=0.233) are not statistically significant. Career development ability (MD15=0.02, p=0.534) and general ability (MD14=0.01, p=1.000) do not differ significantly. Development ability and career development ability do not vary significantly from each other (MD19=0.01, p=1.000). Value and personal quality do not change significantly (MD26=0.01, p=1.000). The difference between the other 4th-level indexes was significant between each two. However,

there was no significant difference between personal and professional quality (MD28=0.02, p=0.326). The above findings further highlight how differently each student develops at each of the four levels of indexes.

Table 5.12: 4th-Level Student Development Index Level

Level	Index name	Mean	Standard	Significance
4th-level index	general knowledge(D1)	0.65	0.15	<.001
	professional knowledge (D2)	0.64	0.19	
	general ability (D3)	0.64	0.14	
	professional ability (D4)	0.63	0.17	
	career development ability (D5)	0.62	0.16	
	value (D6)	0.71	0.21	
	personal quality (D7)	0.70	0.18	
	professional quality (D8)	0.68	0.19	

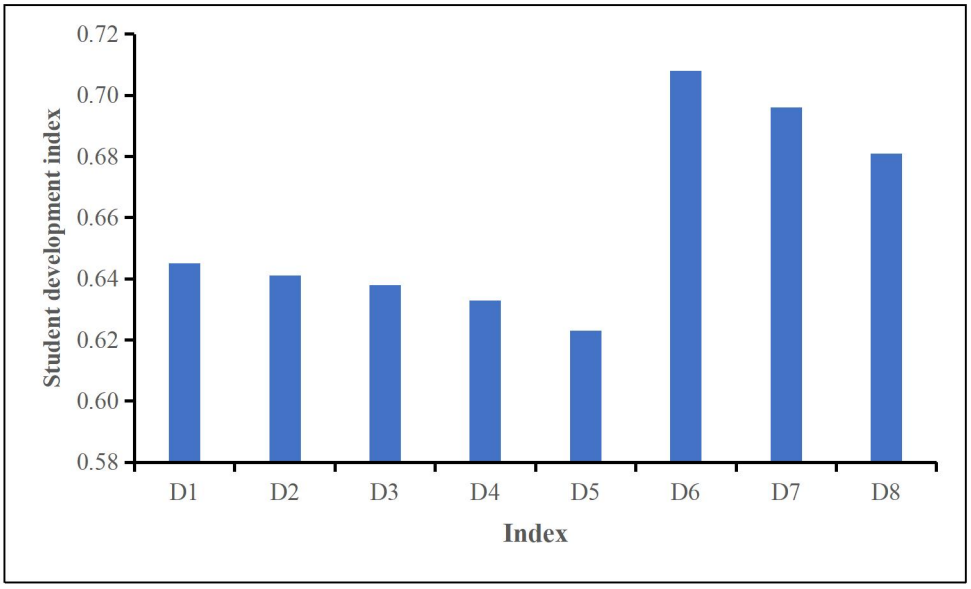

Figure 5.3：4th-Level Student Development Index

Table 5.13: Multiple Comparison Analysis of 4th-Level Student Development Indexes

Control group	Experimental group	Mean difference	Significance
general knowledge	professional knowledge	0.00	1.000
	general ability	0.01	1.000
	professional ability	0.01	1.000
	career development ability	0.02	0.047
	value	-0.06	<.001
	personal quality	-0.05	<.001
	professional quality	-0.04	<.001
professional knowledge	general ability	0.00	0.679
	professional ability	0.01	0.233
	career development ability	0.02	<.001
	value	-0.07	<.001
	personal quality	-0.06	<.001
	professional quality	-0.04	<.001
general ability	professional ability	0.01	1.000
	career development ability	0.02	0.534
	value	-0.07	<.001
	personal quality	-0.06	<.001
	professional quality	-0.04	<.001
professional ability	career development ability	0.01	1.000
	value	-0.08	<.001
	personal quality	-0.06	<.001
	professional quality	-0.05	<.001
career development ability	value	-0.09	<.001
	personal quality	-0.07	<.001
	professional quality	-0.06	<.001
value	personal quality	0.01	1.000
	professional quality	0.03	0.042
personal quality	professional quality	0.02	0.326

b. Development index levels of different groups of students

With the expansion of the scale of higher education and the continuous development of the social economy, students' heterogeneous characteristics have become increasingly obvious. This thesis analyzes and compares the development levels of different groups of students to understand their respective development levels and characteristics.

Development index levels of students of different genders:

Comparison of the development indexes of male and female students (Table 5.14 and Figure 5.4). The mean value of the 1st-level development index was higher for males (0.67) than for females (0.65), and the results of the independent-Samples t-test showed that there was a significant difference in the 1st-level development index between males and females (p<.001), which indicated that the overall development level of male students was superior compared to that of female students. The mean values of both cognitive and non-cognitive development indexes were higher for males than for females in the 2nd-level development index (p<.05), which indicates that males have higher cognitive and non-cognitive development than females. Among the 3rd-level development index, males have higher mean values of knowledge and ability development indexes than females (p<.05), with the largest difference in mean values of knowledge development index (0.02). In contrast, the quality development indexes of males and females (0.70) were equal, which indicates that the level of knowledge and ability development of males was higher than that of females. Still, there was no difference in the quality development level of males and females. Among the 4th-level development indexes, the mean values of professional knowledge, general ability, professional ability, career development ability, personal quality, and professional quality development indexes of male students were significantly higher than those of female students (P<.05), among which the top two were

the mean differences of professional knowledge and career development ability indexes of 0.03. It indicates that the development indexes of male students in these areas were significantly higher than those of female students. However, there is no significant difference in the general knowledge development index between male and female students (p>.05), which showed that the difference between male and female students is insignificant. The value development indexes of male and female students were equal (0.71), which indicates that male and female students have equal levels of development.

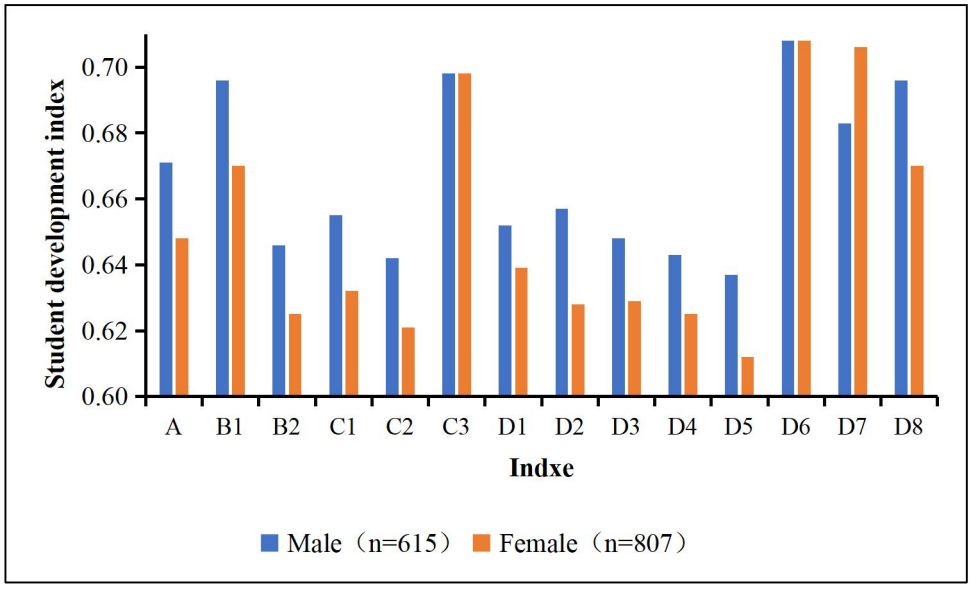

Figure5.4: Development Index of Students by Genders

Table 5.14: Development Index Level of Students of Different Genders

Level	Index		Male (n=615)	Female (n=807)	Significance
1st-level index	A	mean value	0.67	0.65	<.001
		standard deviation	0.13	0.12	
2nd-level index	B1	mean value	0.70	0.67	0.010
		standard deviation	0.20	0.18	
	B2	mean value	0.65	0.63	0.002
		standard deviation	0.13	0.12	
3rd-level index	C1	mean value	0.66	0.63	0.004
		standard deviation	0.15	0.14	
	C2	mean value	0.64	0.62	0.007
		standard deviation	0.15	0.14	
	C3	mean value	0.70	0.70	0.960
		standard deviation	0.16	0.16	
4th-level index	D1	mean value	0.65	0.64	0.101
		standard deviation	0.16	0.14	
	D2	mean value	0.66	0.63	0.004
		standard deviation	0.19	0.18	
	D3	mean value	0.65	0.63	0.014
		standard deviation	0.14	0.14	
	D4	mean value	0.64	0.63	0.047
		standard deviation	0.17	0.16	
	D5	mean value	0.64	0.61	0.004
		standard deviation	0.16	0.16	
	D6	mean value	0.71	0.71	0.958
		standard deviation	0.22	0.21	
	D7	mean value	0.68	0.71	0.019
		standard deviation	0.18	0.18	
	D8	mean value	0.70	0.67	0.010
		standard deviation	0.20	0.18	

Development index level of students in different subjects:

Comparison of the development indexes of students in arts and sciences (Table 5.15 and Figure 5.5). The results of the Independent-Sample t-test showed a significant difference (p<.05) in the 1st-level development index between the arts and sciences students, indicating that the overall development index of the science students was better than that of the art students. The situation of the 2nd-level development index was similar to that of the 1st-level development index, with the mean value of the cognitive development index of

science students being significantly higher than that of art students (p<.001) and the non-cognitive development index is higher than that of art students (p<.05). In the 3rd-level development index, there is a significant difference (p<.05) between the knowledge and ability development indexes of both arts and sciences students, where the mean difference of both knowledge and ability development indexes is 0.03. The quality development indexes of arts and sciences students are equal to 0.70. It indicates that science students are significantly better than arts students in knowledge and ability development. In contrast, the quality development levels of both arts and sciences students are equal. Among the 4th-level development indexes, the mean values of the development indexes of general ability and career development ability of sciences students were significantly higher than those of art students (P<.001), which shows that the development levels of science students in these two areas were substantially higher than those of art students, where the mean values of the development indexes of both were 0.03. The mean values of general knowledge, professional knowledge, professional ability, and professional quality development indexes of science students were higher than those of art students (p<.05), which indicates that the development level of these four areas in science was higher than that of art students. There is no significant difference between arts and sciences students' mean value and personal quality development indexes (p>.05). Still, arts students' value and personal quality development are higher than science students.

Table 5.15: Development Index Level of Students in Different Subjects

Level	Index		Science (n=932)	Art (n=490)	Significance
1st-level index	A	mean value	0.67	0.64	0.001
		standard deviation	0.12	0.13	
2nd-level index	B1	mean value	0.64	0.62	<.001
		standard deviation	0.13	0.12	
	B2	mean value	0.69	0.67	0.037
		standard deviation	0.18	0.20	
3rd-level index	C1	mean value	0.65	0.63	0.001
		standard deviation	0.15	0.14	
	C2	mean value	0.64	0.61	0.001
		standard deviation	0.15	0.13	
	C3	mean value	0.70	0.70	0.968
		standard deviation	0.16	0.16	
4th-level index	D1	mean value	0.65	0.63	0.015
		standard deviation	0.15	0.14	
	D2	mean value	0.65	0.62	0.004
		standard deviation	0.19	0.18	
	D3	mean value	0.65	0.62	<.001
		standard deviation	0.14	0.15	
	D4	mean value	0.64	0.62	0.020
		standard deviation	0.17	0.16	
	D5	mean value	0.63	0.60	<.001
		standard deviation	0.17	0.15	
	D6	mean value	0.71	0.71	0.494
		standard deviation	0.22	0.20	
	D7	mean value	0.69	0.70	0.484
		standard deviation	0.18	0.18	
	D8	mean value	0.69	0.67	0.037
		standard deviation	0.18	0.20	

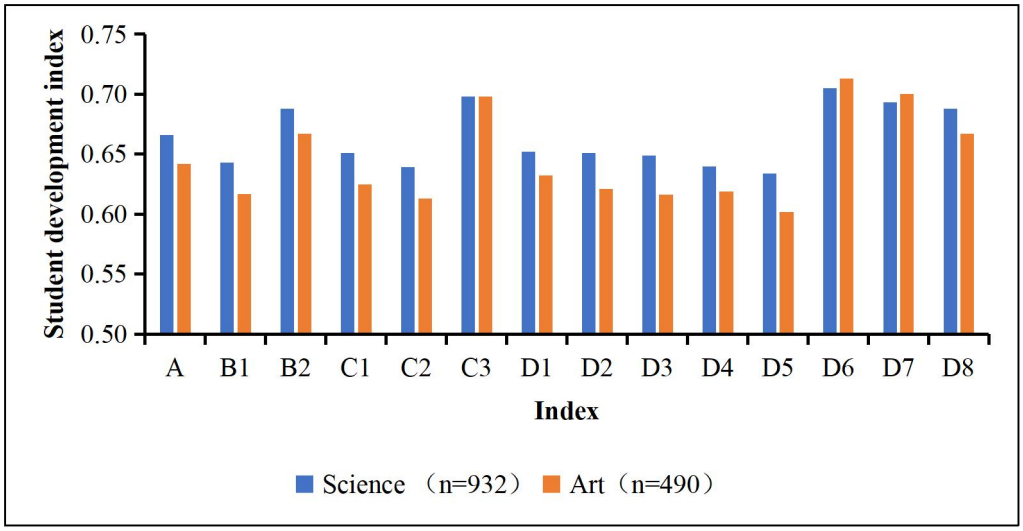

Figure 5.5: Development Index of Students by Subjects

Development index level of students at different grades:

From the comparison of student development indexes in different grades (Table 5.16 and Figure 5.6), the mean values of students' 1st-level, 2nd-level, 3rd-level, and 4th-level development indexes in all four grades are the lowest in grade 1 and the highest in grade 4. The results of the One-Way ANOVA test showed that there were significant differences in the other level indexes ($p<.001$) among the students in different grades, except for some differences in the development of value ($p<.05$) and personal quality ($p<.05$) development.

Further multiple comparison analysis revealed (Table 5.17) that the enormous difference in the mean value of non-cognitive development between fourth-grade and first-grade students (0.11) was found in the 2nd-level index, which indicates that the magnitude of non-cognitive development is much higher than cognitive development among students in the four years of university. In the 3rd-level development index, the smallest increase in the development of students in four years of university is quality development (0.07), followed by ability development (0.08), and the most development is knowledge development (0.10). Among the 4th-level indexes, the largest to the smallest increase in student development is in the order of professional quality, professional knowledge, general knowledge, professional ability, general ability, career development ability, value, and personal quality.

The student development line Figures 5.7, 5.8, and 5.9 show that although there is an overall upward trend in student development over the four years of university, some indexes show slow growth in the third year, or even "stagnation or decline". The line graph of the 1st-level and 2nd-level student development indexes (Figure 5.7) indicates that student development, and cognitive and non-cognitive development, have been showing an upward trend. The non-cognitive development level was consistently higher than the cognitive development level, and the increase in the non-cognitive development index was also greater than the cognitive development index. The line figure of the 3rd-level student development (Figure 5.8) shows that the quality development index of four-grade students is significantly higher than the knowledge and ability development index, and the third-grade students present a fundamental stagnation of quality development. The knowledge and ability development indexes of the first-grade and second-grade students are almost equal. Still, there is stagnation in the ability development of third-grade students. Finally, the student ability development in the four years of university is lower than the knowledge development. The line figure of the 4th-level student development index (Figure 5.9) shows that although there are differences in the increase of the four levels of the student development index, there is an overall upward trend. The more noticeable change is that personal quality development regresses in the third grade, with the stagnant or slow development of general knowledge, general ability, professional ability, and

career development ability. The most significant increase in the development index of third-grade students was in the professional knowledge aspect, followed by the career quality development index. The highest development indexes in the fourth grade were value, personal, and vocational quality in that order, and the lowest were career development, professional, and general abilities. It reflects the characteristics of student development in different dimensions over the four years and manifests the uneven student development.

Table 5.16: Development Index Level of Students in Different Grades

Level	Index		First grade (n=394)	Second grade (n=363)	Third grade (n=366)	Fourth grade (n=299)	Significance
1st-level index	A	mean	0.61	0.65	0.67	0.71	<.001
		standard	0.11	0.12	0.09	0.15	
2nd-level index	B1	mean	0.60	0.63	0.64	0.68	<.001
		standard	0.16	0.12	0.11	0.08	
	B2	mean	0.63	0.68	0.70	0.73	<.001
		standard	0.14	0.18	0.14	0.26	
3rd-level index	C1	mean	0.60	0.63	0.66	0.69	<.001
		standard	0.17	0.14	0.15	0.11	
	C2	mean	0.60	0.63	0.63	0.68	<.001
		standard	0.19	0.14	0.11	0.09	
	C3	mean	0.67	0.69	0.70	0.74	<.001
		standard	0.14	0.15	0.16	0.19	
4th-level index	D1	mean	0.60	0.65	0.65	0.69	<.001
		standard	0.17	0.13	0.13	0.14	
	D2	mean	0.60	0.62	0.67	0.69	<.001
		standard	0.20	0.20	0.18	0.14	
	D3	mean	0.60	0.63	0.65	0.68	<.001
		standard	0.17	0.15	0.12	0.11	
	D4	mean	0.60	0.63	0.64	0.68	<.001
		standard	0.21	0.16	0.15	0.11	
	D5	mean	0.60	0.62	0.62	0.67	<.001
		standard	0.21	0.15	0.13	0.12	
	D6	mean	0.68	0.70	0.72	0.74	0.003
		standard	0.20	0.21	0.22	0.22	
	D7	mean	0.68	0.70	0.68	0.73	0.001
		standard	0.18	0.15	0.20	0.17	
	D8	mean	0.63	0.68	0.70	0.73	<.001
		standard	0.14	0.18	0.14	0.26	

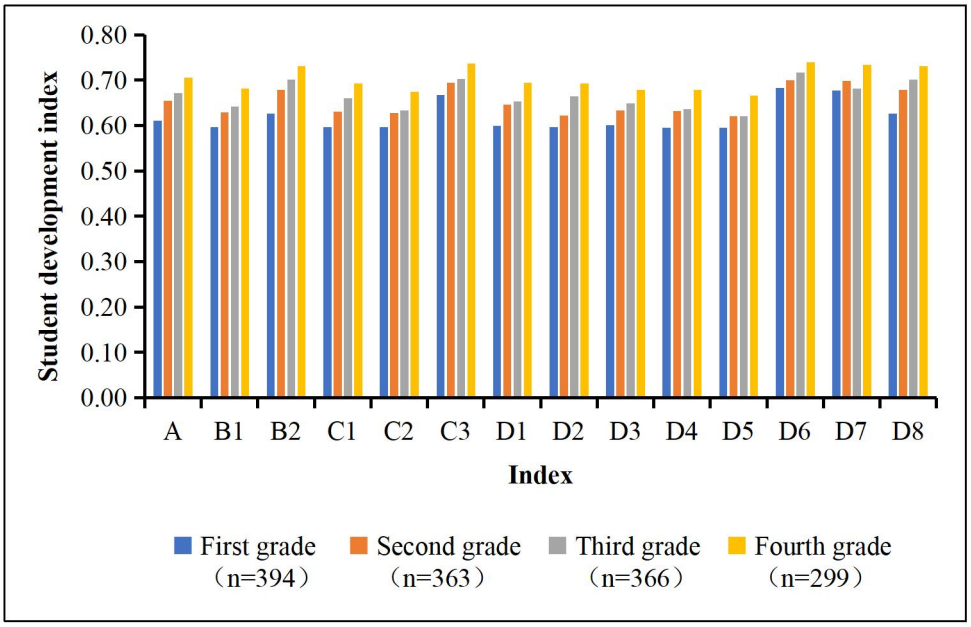

Figure 5.6: Development Index of Students by Grades

Table 5.17: Multiple Comparison Analysis of Student Development Indexes in Different Grades

Index	Control group	Experimental group	Mean difference	Significance
A	first grade	second grade	-0.04	0.223
		third grade	-0.06	<.001
		fourth grade	-0.10	<.001
	second grade	third grade	-0.02	<.001
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.03	0.003
B1	first grade	second grade	-0.03	0.229
		third grade	-0.05	0.002
		fourth grade	-0.09	<.001
	second grade	third grade	-0.01	0.909
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.04	<.001
B2	first grade	second grade	-0.05	<.001
		third grade	-0.08	<.001
		fourth grade	-0.11	<.001
	second grade	third grade	-0.03	0.331
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.03	0.041
C1	first grade	second grade	-0.03	0.046
		third grade	-0.06	<.001
		fourth grade	-0.10	<.001
	second grade	third grade	-0.03	0.126
		fourth grade	-0.06	<.001
	third grade	fourth grade	-0.03	0.003
C2	first grade	second grade	-0.03	0.515
		third grade	-0.04	0.061

Table 5.17 continue next page

Index	Control group	Experimental group	Mean difference	Significance
C2	second grade	fourth grade	-0.08	<.001
		third grade	0.00	1.000
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.04	<.001
C3	first grade	second grade	-0.03	0.053
		third grade	-0.04	0.002
		fourth grade	-0.07	<.001
	second grade	third grade	-0.01	1.000
		fourth grade	-0.04	0.005
	third grade	fourth grade	-0.03	0.106
D1	first grade	second grade	-0.05	0.001
		third grade	-0.05	<.001
		fourth grade	-0.09	<.001
	second grade	third grade	-0.01	1.000
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.04	<.001
D2	first grade	second grade	-0.03	0.073
		third grade	-0.07	<.001
		fourth grade	-0.10	<.001
	second grade	third grade	-0.04	1.000
		fourth grade	-0.07	<.001
	third grade	fourth grade	-0.03	0.176
D3	first grade	second grade	-0.03	1.000
		third grade	-0.05	0.001
		fourth grade	-0.08	<.001
	second grade	third grade	-0.02	0.092
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.03	0.013
D4	first grade	second grade	-0.04	0.382
		third grade	-0.04	0.115
		fourth grade	-0.08	<.001
	second grade	third grade	0.00	1.000
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.04	<.001
D5	first grade	second grade	-0.03	1.000
		third grade	-0.03	1.000
		fourth grade	-0.07	<.001
	second grade	third grade	0.00	1.000
		fourth grades	-0.05	<.001
	third grade	fourth grade	-0.05	<.001
D6	first grade	second grade	-0.02	1.000
		third grade	-0.03	0.890
		fourth grade	-0.06	<.001
	second grade	third grade	-0.02	0.710
		fourth grade	-0.04	0.012
	third grade	fourth grade	-0.02	0.638
D7	first grade	second grade	-0.02	1.000
		third grade	-0.01	1.000
		fourth grade	-0.06	0.001
	second grade	third grade	0.02	1.000
		fourth grade	-0.04	0.004
	third grade	fourth grade	-0.05	0.014

Table 5.17 continue next page

Index	Control group	Experimental group	Mean difference	Significance
D8	first grade	second grade	-0.05	<.001
		third grade	-0.08	<.001
		fourth grade	-0.11	<.001
	second grade	third grade	-0.03	0.331
		fourth grade	-0.05	<.001
	third grade	fourth grade	-0.03	0.041

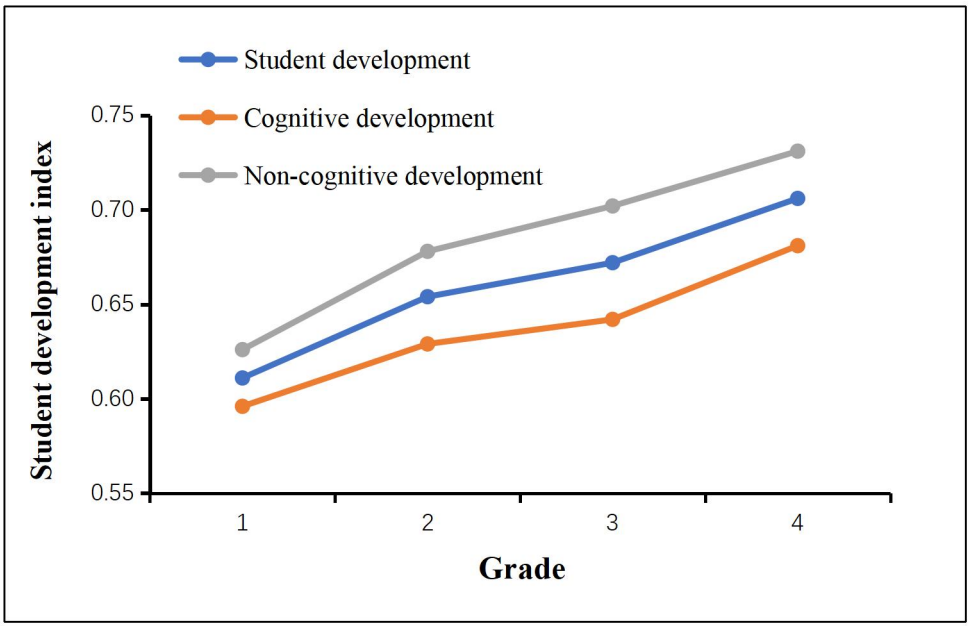

Figure 5.7: 1st-Level and 2nd-Level Student Development Index in Undergraduate Vocational Universities

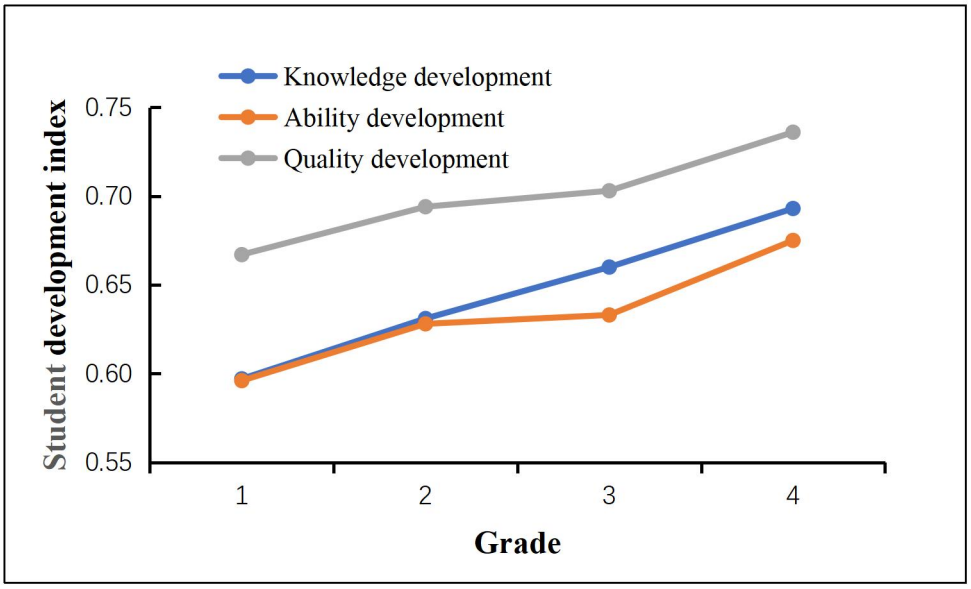

Figure 5.8: 3rd-Level Student Development Index in Undergraduate Vocational Universities

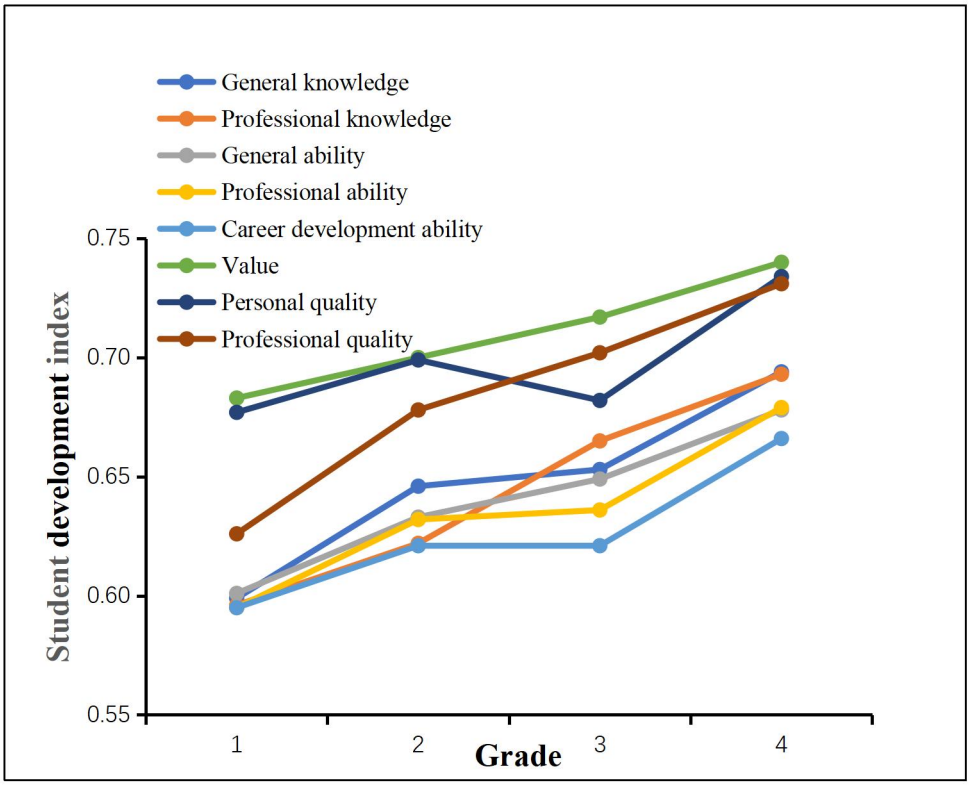

Figure 5.9: 4th-Level Development Index of Students in Undergraduate Vocational Universities

Developmental index level of students in different universities:

Comparison of student development indexes in different universities (Table 5.18). The results of the One-way ANOVA test showed that there were no significant differences between the students of the three universities in the 1st-4th level indexes (p>.05), except in the general ability, career development ability, and career quality development indexes (p<.05).

Further multiple comparison analysis revealed (Table 5.19 and Figure 5.10) that the most significant difference in the mean value of the student development index between the three universities was in the mean value of the general ability development index between the students of University 2 and

University 3 (0.03). Also, University 1 and University 2 students developed their personal qualities differently (p<.05). There is some variation in general ability between students from University 1 and University 3 (p<.05). Other indexes did not significantly differ between the two universities (p<.05). According to the aforementioned findings, there are no appreciable differences between the overall development levels of students in the three universities.

Table 5.18: Student Development Index Level of Different Universities

Level	Index		University 1 （n=478）	University 2 （n=450）	University 3 （n=494）	Significance
1st-level index	A	mean value	0.66	0.65	0.66	0.111
		Standard deviation	0.13	0.12	0.12	
2nd-level index	B1	mean value	0.63	0.63	0.64	0.217
		standard deviation	0.12	0.13	0.13	
	B2	mean value	0.69	0.67	0.69	0.170
		standard deviation	0.20	0.17	0.18	
	C1	mean value	0.64	0.64	0.65	0.573
		[illegible]	[illegible]	[illegible]	[illegible]	
3rd-level index	C2	mean value	0.63	0.63	0.64	0.452
		standard deviation	0.14	0.15	0.14	
	C3	mean value	0.70	0.69	0.70	0.335
		standard deviation	0.17	0.14	0.17	
	D1	mean value	0.64	0.65	0.65	0.652
		standard deviation	0.14	0.15	0.15	
	D2	mean value	0.64	0.64	0.65	0.703
		standard deviation	0.18	0.19	0.19	
	D3	mean value	0.64	0.62	0.65	0.005
		standard deviation	0.14	0.15	0.14	
4th-level index	D4	mean value	0.63	0.63	0.64	0.772
		standard deviation	0.17	0.17	0.16	
	D5	mean value	0.63	0.61	0.63	0.046
		standard deviation	0.15	0.18	0.16	
	D6	mean value	0.70	0.71	0.71	0.622
		standard deviation	0.22	0.19	0.22	
	D7	mean value	0.71	0.69	0.69	0.033
		standard deviation	0.18	0.18	0.18	
	D8	mean value	0.69	0.67	0.69	0.170
		standard deviation	0.20	0.17	0.18	

Table 5.19: Multiple Comparison Analysis of Student Development Indexes in Different Universities

Index	Control group	Comparison group	Mean difference	Significance
A	University 1	University 2	0.01	0.332
		University 3	0.00	0.972
	University 2	University 3	-0.02	0.126
B1	University 1	University 2	0.00	0.993
		University 3	-0.01	0.708
	University 2	University 3	-0.01	0.577
B2	University 1	University 2	0.02	0.183
		University 3	0.00	1.000
	University 2	University 3	-0.02	0.173
C1	University 1	University 2	0.00	0.978
		University 3	-0.01	0.694
	University 2	University 3	-0.01	0.913
C2	University 1	University 2	0.01	0.607
		University 3	-0.01	0.457
	University 2	University 3	-0.01	0.211
C3	University 1	University 2	0.01	0.687
		University 3	0.00	1.000
	University 2	University 3	-0.01	0.715
D1	University 1	University 2	-0.01	0.561
		University 3	-0.01	0.362
	University 2	University 3	0.00	0.755
D2	University 1	University 2	0.00	0.861
		University 3	-0.01	0.424
	University 2	University 3	-0.01	0.541
D3	University 1	University 2	0.01	0.234
		University 3	-0.02	0.043
	University 2	University 3	-0.03	0.001
D4	University 1	University 2	0.00	0.769
		University 3	-0.01	0.475
	University 2	University 3	0.00	0.684
D5	University 1	University 2	0.02	0.103
		University 3	0.00	1.000
	University 2	University 3	-0.02	0.080
D6	University 1	University 2	-0.01	0.928
		University 3	-0.01	0.726
	University 2	University 3	-0.01	0.962
D7	University 1	University 2	0.03	0.015
		University 3	0.02	0.113
	University 2	University 3	-0.01	0.666
D8	University 1	University 2	0.02	0.183
		University3	0.00	1.000
	University 2	University 3	-0.02	0.173

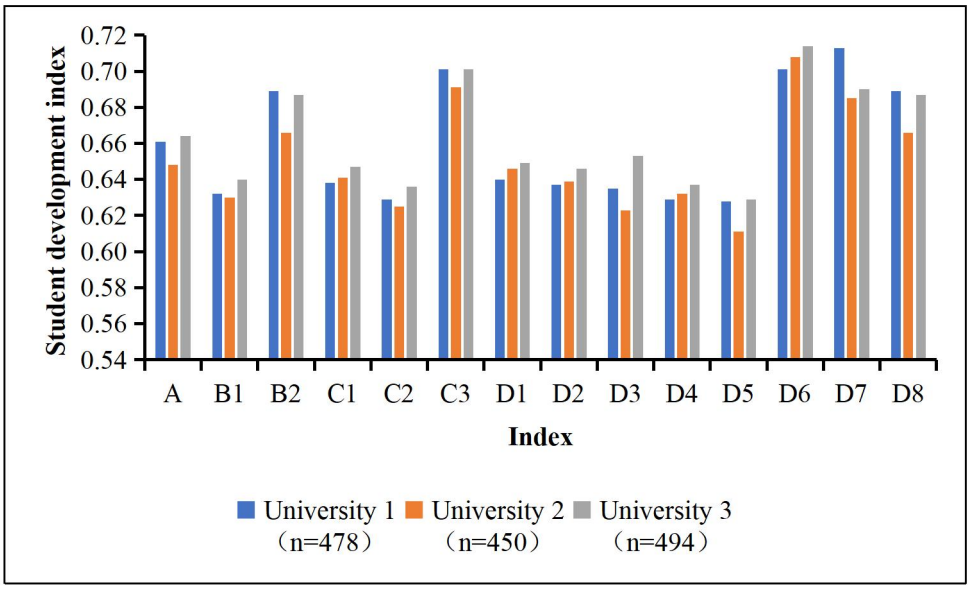

Figure 5.10: Development Index of Students by Universities

c. Analysis and Evaluation of Student Development Level

Based on the empirical evaluation data of student development, this section analyzed and evaluated the specific development levels and differences of students in terms of the overall level, between individuals, different dimensions, and the development of different groups of students, which can help undergraduate vocational universities to grasp the actual state of student development.

The overall level of student development index is in the middle to upper level.

The mean value of the 1st-level student development index is 0.66, which indicates that student development in undergraduate vocational universities is generally moderate to high. And the 2nd-4th level development indexes are also

all at 0.62 and above, which shows that students have achieved a certain degree of development in all indexes. This result is consistent with the findings of Wang Shiluo's study on students' learning gains in knowledge, ability, and value are higher than the theoretical mean (Wang, 2018).

Students' gain in cognition, skills, and attitudes are the core criteria for measuring the quality of higher education (Chen, 2004). As the scale of higher education continues to expand, China has made improving the quality of higher education talent training a primary issue in developing higher education to achieve the transformation from a large higher education country to a strong one. To comprehensively guarantee and improve the quality of talent training in higher education, China MOE has issued several systems to promote the improvement of talent training quality: "The Opinions of the Ministry of Education on Deepening Teaching Reform of Vocational Education to Comprehensively Improve the Quality of Talent Training (MOE, 2015)" "The Opinions of the Ministry of Education on Accelerating the Construction of High-level Undergraduate Education to Improve Talent Cultivation Comprehensively (MOE, 2018)" "The Opinions of the Ministry of Education on Deepening Teaching Reform of Undergraduate Education to Comprehensively Improve the Quality of Talent Training (MOE, 2019)", etc. Universities in various places also continue to deepen education and teaching reform under the guidance of national macro policies and take different

measures to improve talent cultivation quality. Therefore, the reality that student development is generally at the upper middle level cannot be separated from the various guarantees the state and universities provide.

There are differences in development indexes among individual students.

The result of the T-test shows significant differences between individual students in the mean values of development indexes at the 1st-4th level, indicating substantial individual differences in student development level.

Marx believed that human development is the free and full development of human personality, and it is the unity of commonality and difference, unity and particularity (Marx, 1972). The famous philosopher Leibniz said, “There are no two leaves exactly alike, and there are no people with the same character in the world”. Whether it is a person’s fingerprint or temperament, learning, character, etc., they cannot be the same, which shows that the differences between people exist objectively. The gap between the best and the average students in the university is noticeable, and the differences in development between individuals are significant. For example, some students in the university are among the top students, won national scholarships and national awards in the university innovation and entrepreneurship competitions, got the honor of a provincial outstanding student, and were guaranteed to graduate

students in famous universities. While some students are ordered to withdraw from the university because they failed to take the credits required for graduation, some students are seriously punished for misconduct or violation of law and discipline, which affects their future graduation or job search. There are many reasons for individual differences. For example, their genetic factors, preschool experiences, family of origin, learning behaviors, school conditions, and social influences influence students' development. Each student's development is affected by these factors to a different extent (Zhou & Zhou, 2012). It requires universities to actively utilize the function and diversity of education and teaching and develop different students' learning and developmental abilities to improve their overall quality and help more students achieve self-development.

There are differences in the development index level among students in each dimension.

The results of the One-way ANOVA test show significant differences in students' development indexes in different dimensions. It indicates an imbalance in the student's knowledge, ability, and quality development.

Soviet educator Sukhomlinsky advocated "harmonious education". He believes that education should be aimed at cultivating "a person with a comprehensive and harmonious development of personality" to give full play

to the nurturing factor to promote the harmonious development of student quality (Chen, 2004). In February 1957, Mao Zedong proposed in On the Correct Handling of the Internal Contradictions of the People that “our educational policy should enable the educated to develop in moral, intellectual and physical education, and to become educated workers with socialist consciousness.” This important statement informs the Marxist idea of the all-round development of human beings in the socialist education cultivation goals, forming the new Chinese policy of all-round development of socialist education. In 1999, China issued the Decision on Deepening Education Reform and Promoting Quality Education Comprehensively, which marked the formal entry of this China into the era of quality education, indicating that cultivating individual students into a well-rounded person is one of the relentless pursuits of Chinese education. However, the reality is that the uneven development of students is common. For example, some students excel in science and technology subjects such as physics, chemistry, and Mathematics, have hands-on skills and knowledge, transfer, and have high interpersonal skills. Still, they have difficulties learning languages such as English, and their writing skills are mediocre.

On the other hand, some students have an easy time learning and excelling in English and languages but are weak in mathematics, chemistry, logical thinking, and particularly weak in practical skills. There are numerous

examples of uneven student development, which shows that unevenness is common. There are many reasons for it. For instance, from the perspective of physiology and psychology, human development is sequential and stage-specific. The development of each individual has a different development speed and focus at different age stages, which makes different students form their development characteristics and inconsistency of development among various elements. Therefore, to achieve the educational goal of all-round development of students and to improve the problem of uneven development of individual students, the joint efforts of students, families, universities, and society are still needed.

There is a significant difference in the development index level between students of different genders.

The mean value of the 1st-level development index was higher for males than females, indicating that males have a higher development level than females. The mean values of cognitive and non-cognitive development indexes were significantly higher for males than for females in the 2nd-level development index. In the 3rd-level index, the mean value of knowledge and ability development indexes were higher for males than for females. Still, the mean value of quality development indexes was equal for both, which indicates that males have better knowledge and ability development level than females, but both have equal quality development levels. Regarding the 4th-level index,

there is no significant difference between male and female students' mean value of value and personal quality development indexes. Still, the development of the value of male and female students is equal, and the development level of personal quality of female students is higher than that of male students. Except for value and personal quality, the other 4th-level indexes' mean value is higher for male students than for female students. The significant difference in development levels is in the two development areas of professional knowledge and career development ability.

British scholar Stephanie Atkinson found significant differences in academic achievement between male and female students after several studies (Atkinson, 2008). The results of Sun Ruijun et al.'s (2012) study showed significant differences in the acquisition of knowledge skills between male and female students. The research of Yang Lijun and Han Xiaoling - What influences the research gains of college students shows that gender has a significant effect on the educational gains of college students. Male and female students have different student development (Yang & Han, 2014). He Xiangling found, after an empirical research study, that there are significant differences in the development of male and female students and that male students are significantly better than female students in problem-solving and other abilities (He, 2019).

The three universities investigated in this thesis represent undergraduate vocational universities in China. These universities focus on developing students' abilities in logical reasoning, practical operations, and solving practical problems. From human physiological and intellectual analyses, male students have an advantage in spatial, logical reasoning, and practical skills compared to female students, making it possible for them to improve their knowledge and ability faster and more effectively. In addition, male students are more capable of learning, integrating, and converging knowledge and applying theoretical knowledge to solve practical problems. Therefore, they gain more from improving their thinking skills and problem-solving ability. Girls have delicate emotions, are good at communicating with others, and are willing to participate in learning and social practice activities inside and outside the university. Therefore, their quality development is more comprehensive (Wang & Chen, 2018).

The development index level of students in different subjects are significantly different.

The mean value of the 1st-level index development for science students is significantly higher than that of art students, which indicates that the development level of science students is higher than that of art students. The mean value of cognitive and non-cognitive development indexes of science students is higher than that of art students. The mean value of knowledge and

ability development indexes for science students is higher than for arts students in the 3rd-level development indexes. Still, the mean value of the quality development index for arts and science students was equal. It indicates that the knowledge and ability development level of science students is higher than that of art students, but the quality development of arts and science students is equivalent. Among the 4th-level development indexes, except in two aspects of value and personal quality, female student development indexes are higher than male students. The development index of all other 4th-level indexes is higher for male students than for female students, and the differences are more significant for general ability and career development ability.

The setting of different disciplines and specialties in colleges and universities is based on their categories, positioning, and talent cultivation goals, aiming to make talent cultivation's characteristics significant and maximize the quality of talent cultivation. The state will provide different educational resources and guarantees according to each university's category, positioning characteristics, and cultivation focus. Especially with the promotion of first-class universities and disciplines, the proposal and establishment of applied undergraduate universities and undergraduate vocational universities, the positioning of each university's development, and the focus on talent cultivation are more clearly defined. In this thesis, three undergraduate vocational universities are investigated. According to their

positioning and talent cultivation goals, the universities' investment in funding, faculty, teaching, and research are more inclined to science and technology majors, and more attention and support are given to science and technology majors compared to arts. In addition, in terms of the actual situation of the surveyed universities, more students are studying the arts than the sciences, and 87.60% of students studying the arts are women compared to 59.40% of sciences students who are men. The reasons for the difference in the development level of arts and sciences students can also be traced by referring to the analysis of the development differences of students of different genders.

Significant differences in the development index level of students in different grades.

The mean value of all level development indexes of students in the four grades showed an overall increasing trend year by year, and the fourth grade was at the highest development level, which indicates that the student development level show increasing changes with the increase of grades. The results of the One-way ANOVA test showed significant differences in most of the 1st-4th-level indexes for students in different grades, which showed substantial differences in the development level of students in different grades.

After studying undergraduate students' general academic self and related factors, Luo Yun concluded that students' academic abilities performed

differently in different grades and were positively related to grade level (Yun, 2012). After comparing ability development between grades, Cui Yuhua found that students' abilities, such as organizational leadership and problem-solving, increased significantly with grade level (Cui, 2014). Yang Lijun's study showed that after four years of university education and practice, fourth-grade students' knowledge, abilities, values, and interpersonal relationships improved significantly, and their development levels gradually increased with increasing grade levels (Yang, 2018). The developmental increase of second-grade students in this thesis was larger compared to other grades. However, the student's general, professional, and career development ability in this thesis regressed or stagnated in the third grade. It is in line with the findings of some scholars that "third-grade decline" in students' academic development occurs (Guo, 2014). Thus, studies have shown that senior students' development level is better than junior students, and the development of fourth-grade students is at the highest point during their university years. However, the increase in each grade varies widely, and there is a large difference in the increase of different indexes.

Differences exist in the student development index level in different universities.

The results of the One-way ANOVA test showed no significant differences in the mean value of the 1^{st}-4^{th}-level indexes among the students of the

different universities, except for the differences in the general ability, career development ability, and career quality development indexes. It indicates that the differences in student development levels among the three universities are insignificant.

Ren Shijun et al. found that different universities differ in student source, subject setting, faculty, input, and student perception, and different universities differ in teaching quality and student training quality (Ren & Yang, 2018). The results of Qi Xiaosi's study after research on the quality of talent cultivation of music majors in universities - taking 17 undergraduate universities in province H as an example - showed significant differences in the quality of talent cultivation of music majors in different universities in the same region. The universities also differed in faculty structure, research and creative achievements, and social services (Qi, 2021). This thesis surveyed three undergraduate universities that transformed and upgraded from vocational colleges. Their transformation bases, development characteristics, and training priorities differ, and their major settings and development directions are also distinctive. Their student development levels and characteristics are different, but the overall development of the three universities is not very different. Therefore, the three universities can learn from each other and complement each other's strengths and weaknesses to jointly promote the maximum student

development level, further promote the overall development of students and improve the quality of talent cultivation.

5.2 Suggestions for Improving Student Development Level

The purpose of establishing the student development construct in this thesis is to provide a clear and specific reference for talent development in undergraduate vocational universities. The focus of student development level evaluation is to verify the effectiveness of the evaluation method and, more importantly, to be able to objectively reflect the development level and characteristics of students, which can help universities find more effective methods or approaches to continuously improve and optimize student development, and ultimately achieve whole-person and all-round development of students. Combining the analysis results of the previous empirical study, this section proposed several suggestions for improving student development in undergraduate vocational universities in China from three perspectives promoting the overall level of student development, all-round development of each dimension, and all-member development of different groups of students.

5.2.1 Focus on All Students and Improve Their Overall Development Level

Overall, the 1st-4th-level student development index ranged from 0.6 to 0.7 (exceeding the theoretical mean), which indicates that the student development index is generally at a moderate to high level but does not reach the ideal

development level. Based on the theory of high correlation between student engagement and higher education quality evaluation (Zhao, 2014), this thesis makes several recommendations for student development in Chinese undergraduate vocational universities to improve student engagement.

a. China should change the main body of higher education quality evaluation

Most traditional education quality evaluation in China takes universities and teachers as the evaluation subjects, and it fails to pay sufficient attention to students' process experience of receiving higher education. The traditional evaluation methods usually take the university's human, financial, and material resources as the primary input indexes. The number of output students, the number of major national projects completed, and the relevant awards won as the primary output indexes to evaluate the quality of higher education, with little quantitative assessment of the teaching process and the specific student development.

The evaluation of higher education talent quality should switch from resource input to resource utilization rate, from course quantity to course quality in the curriculum, and from volume to average borrowing rate in the library collections. Only when students fully utilize the educational resources possessed by universities, can the quality of talent cultivation in universities be

truly improved. Therefore, higher education should shift the evaluation subject from universities to students as soon as possible. In designing the objectives and system of higher education quality evaluation, universities should change from the traditional “school evaluation” to “student evaluation” (Huang, 2010). In this way, universities can fulfill the mission of high-quality talent cultivation given by the state, and students can achieve real high-quality development.

b. Universities value student experience and improve student engagement

The student experience is the driving force behind improving the quality of higher education talent development. George Kuh, who has studied student experience and engagement, has pointed out that “student self-reports may be the only useful source of data for assessing student learning outcomes”. In Europe and North America, many countries have incorporated student experience into the content of nationwide quality assurance systems for higher education, and they value student engagement in various activities while in the university.

Student engagement is one of the most essential forms of student experience. The concept of student engagement has a dual-core characteristic. On the one hand, it refers to the time and energy students invest in effective educational practices. On the other hand, it focuses on the service environment that universities can provide to facilitate students’ participation in teaching and

learning activities. Student participation evaluation has become a new standard for measuring the quality of higher education and an essential basis for universities to reform their talent cultivation model. The quality of a university's education and talent development is measured by its ability to provide educational resources that increase student participation in various educational activities.

Through an empirical study, Zhao Xiaoyang found that different forms of learning engagement positively and directly impact the development of students' various abilities in the university (Zhao, 2014). Universities can only promote the development of students' various comprehensive abilities by promoting the degree of their participation in learning and social practices during the university. Growing student engagement in academic activities encourages the growth of all cognitive abilities, whereas increasing engagement in social activities encourages the development of students' practical and emotional abilities.

c. Universities build environments that stimulate student engagement

The famous scholars Pascarella and Trenzini (2005) have pointed out in their works that the size of a university's influence on students is primarily determined by the level of individual efforts and participation in various educational activities during the students' university years.

University environment factors include the setting and construction of curriculum content, the motivation and guidance of teachers for student participation, and the services and hardware environment provided by the university. When designing the educational environment, universities should create an environment that enhances students' effective participation in educational practices and promotes their development.

For example, additional courses that develop students' practical skills are needed in the curriculum. The format of the courses should also promote students' active participation inside and outside the classroom to enhance students' independent learning ability, thinking, and critical thinking ability. Students should be encouraged to integrate classroom content with practice to improve their ability to analyze and solve real-world problems and to enhance their professional development. Teachers should guide students in inquiry-based learning. They actively communicate and interact with students inside and outside the classroom, positively guide them in their learning and activities, and promote maximum student participation in educational activities. In addition, teachers should guide students to participate in professional practice and develop their creative ability to apply their professional knowledge to practical work. Universities should try to create opportunities for students to communicate and interact, encourage students to participate in

university management practices, and provide maximum support for students' learning and living in the hardware environment.

In short, universities should shift their focus from traditional university resource allocation to creating educational service environments that help motivate students to participate in various university activities. Educational practices and resources should be directed more toward activities, programs, and conditions that promote student engagement during the university.

5.2.2 Balance Different Dimensions and Promote Students' All-Round Development

The data analysis results show uneven development of individual students in each dimension of knowledge, ability, and quality. The quality development index is higher than the knowledge development index, and the ability development index is the lowest. Among the eight 4th-level indexes, the three ability indexes of career ability development, professional ability, and general ability are in the last three places. It is a big gap with the reality that vocational university students' ability is the most essential need. Also, among the eight 4th-level indexes in this thesis, the weight of career ability development ranks second among the eight 4th-level indexes. Low professional ability development primarily affects the evaluation of student development effects. It requires universities to make up for the shortcomings of ability development, narrow the differences among the dimensions of student development, and

achieve all-round development of students. This thesis proposes the following recommendations for student ability development in undergraduate vocational universities from the perspective of their ability-focused characteristics.

a. Improve the quality of internship practice and highlight the characteristics of vocational education ability

There are apparent differences between undergraduate vocational universities and regular undergraduate universities in the direction of student training. Undergraduate vocational universities should fully recognize and understand this difference, clarify that vocational education is a work-oriented goal, and provide students with high-quality work-based learning internship opportunities.

The core learning content of undergraduate vocational university students is adapting to future occupations or occupational groups. Work-study integration and the integration of theory and practice are the characteristics of teaching in undergraduate vocational universities. Learning oriented to developing work abilities, not just acquiring knowledge, is carried out. Following the logic of ability development, universities follow the principle of work process systematization to develop students' work cognitive and job practice skills, which is the foundation of undergraduate vocational universities.

The survey found that enterprise internships have a significant, even decisive, influence on the quality of vocational education talent training (Zhu, 2021). Especially for undergraduate vocational university students with low ability development, education departments, universities, and enterprises should give internships the same or more critical status as classroom teaching and on-campus practical training. It is suggested that the quality of apprenticeships should be improved in three aspects: optimization of resources, process tracking, and result evaluation to effectively promote students' ability development. First, build a high-quality internship platform, and choose internship enterprises that match well with the university or professional talent training goals to lay the foundation for improving the nurturing quality of internships. The second is to supervise the internship process and guide students to develop the habit of recording the internship process, making plans, and researching and judging to have better self-decision, operation, and migration ability after finishing the internship. Third, establishing the "master and apprentice one-to-one support" mechanism to evaluate the internship results. The university and the enterprise should jointly select the enterprise mentor, set requirements for their performance and conduct, ensure that they can guide the students' internship, and establish a system of communication and evaluation of the internship results to share information.

b. Strengthen the construction of "dual-teacher" teachers and enhance teachers' ability to educate people in practice

The development of vocational education has put forward higher requirements for teachers. Due to the "cross-border" characteristics of vocational education and the imperfect teacher training mechanism, there are always structural problems in China's vocational education teachers' team: Teachers who join directly from university are weak in practical ability, and teachers with enterprise backgrounds are not good at teaching. Despite rapid technological and social development, they lack adequate modern educational concepts and techniques (Zhao & Gao, 2022).

To improve the quality of vocational education personnel training, in 2022, the Chinese MOE issued the Notice of the General Office of the Ministry of Education on the Identification of "Dual-Teacher" Teachers in Vocational Education, which requires that "dual-teacher" teachers should be familiar with the situation of industry and enterprises. They need appropriate professional skills and working or practical experience in industry and enterprises. Teachers must grasp vocational education laws and teach the special group of students in undergraduate vocational universities.

However, the current training for vocational education teachers is diverse but mixed, and teachers are overwhelmed by various projects and competitions, and other activities, which leads to many teaching reforms in a formal way. It is

recommended that undergraduate vocational universities stimulate teachers' enthusiasm for teaching and improve their ability to educate people. First, enhance the professional identity of teachers. Universities give full play to the role of teachers in university construction and development and encourage teachers to participate in democratic decision-making and management of universities, which is the basis of teachers' capacity development. Second, pay attention to teachers' development needs. The university provides targeted professional and vocational training and program support to professionalize and expertize their teaching abilities and support them to develop their teaching innovation and practice better. Third, create an excellent working atmosphere. It is imperative to develop undergraduate vocational education. Still, universities need to provide teachers with a certain space for reflection and development and strengthen the optimization of the work environment to reduce their burnout and enhance their confidence in development.

c. Clarify the goal of education and cultivate students' vocational identity

Research has found that vocational identity is essential to vocational university students' vocational ability development (Zhao & Zhao, 2022). Blankertz (1983) pointed out that "students must accept a specific occupational role and identify with it. Otherwise, it is impossible to acquire occupational ability". Undergraduate vocational universities should focus on the education of students' vocational identity. Currently, career identity education in

undergraduate vocational universities is weak. Less education is carried out for students' career role experience, career spirit cultivation, and career value identification, and students' career identity is not high. It affects the improvement of their vocational ability and literacy.

The learning process of undergraduate vocational university students should contain two parts: vocational ability and vocational identity development. Developing vocational ability and forming a vocational identity requires accumulating reflective work experience, which can only be achieved through practical participation in a vocational community (Wang, 2014). According to the "reflective practitioner" theory of understanding, universities need to create opportunities for students to solve complex problems through "reflective dialogue with unique and uncertain contexts" and use the tacit knowledge developed through experience to effectively promote students' sense of professional identity. It allows students to gain a sense of professional value and identity.

In addition, through work-based learning (including various job learning), students acquire skills and internalize work norms, professional ethics, and values. Through deliberate or episodic learning in multiple places, such as engineering integration and school-enterprise cooperation, students can comprehensively construct their personal ideals and development orientations

and realize the coordinated development of their personality traits, vocational ability, and career plan ability. It can help students construct the prototype of their professional development abilities, such as job innovation, career transition, career migration, and cultivate professional qualities, such as professional ethics and craftsmanship.

5.2.3 Narrow Group Gaps and Promote Students' All-Member Development

In terms of the development of different groups of students, except for the non-significant differences between universities, there are significant differences in the levels of student development indexes between males and females, arts and sciences subjects, and different grades, which requires universities to adopt targeted classification education according to the actual development of different groups of students, to achieve the common development of all students ultimately.

The difference in the level of the gender development index is seen. The development index level of knowledge and ability of male students is significantly higher than that of female students. It requires universities to provide more educational resources, create more opportunities for females to learn and practice, and encourage them to participate in relevant practices actively. Teachers need to be aware of the differences between males and females. Teachers should pay more attention to females' mastery of knowledge

and ability, provide them with more opportunities for learning guidance and hands-on practice, and purposefully change the teaching mode to train and improve girls' cognitive thinking and practical abilities.

5.3 Chapter Summary

This chapter first introduced the research sample and survey procedures of this thesis. Then, the concept of the student development index was discussed, and the overall student development level was explored by statistically processing the collected student development data with SPSS software. The results of the thesis indicated that the overall student development level was moderately high, that there were significant differences in development among individual students, and that there were imbalances in the development of students in different dimensions. This thesis also analyzed and cross-sectionally compared the development of students by different groups and found significant differences in development among students by gender, subjects, and grade,s and little difference in development among students from different universities. Finally, this thesis targeted countermeasures and suggestions to improve student development in three aspects: overall students, each dimension, and all members.

CHAPTER 6

SUMMARY AND OUTLOOK

The researcher provided undergraduate vocational education policymakers, talent development programmer setters, students, and researchers with a holistic perspective to understand better and assess the concerns and priorities of undergraduate vocational universities and student development. It will enable universities to optimize resource allocation by focusing on critical student development indexes. In response to these indexes, universities can develop effective educational and pedagogical measures or adapt appropriate reforms to increase engagement in these student development indexes, thereby improving overall student development. In addition, researchers can help students' outstanding development in critical indexes by conducting in-depth research on the specific landing measures or methods for each of the most critical indexes.

6.1 Discussion and Conclusion

This thesis addressed the problems of unclear talent training goals and student development levels in newly built undergraduate vocational universities in China, designed a student development construct for them, developed a student development instrument, evaluated and analyzed student

development levels in multiple dimensions, and proposed suggestions for improving student development level in Chinese undergraduate vocational universities based on empirical research. The research work of this thesis has the following specific parts.

a. It is argued that OBE theory applies to studying student development in undergraduate vocational universities.

This thesis summarized that OBE theory and undergraduate vocational university student development system have two consistent research subjects and objectives. From the three aspects of design objectives, evaluation objectives, and evaluation methods, it deduced how OBE theory could guide the undergraduate vocational university student development system to meet China's demand for high-quality tech talents. It argued that OBE theory applied to the design of undergraduate vocational university student development system, which is an innovation of OBE theory application and provides the theoretical basis for this thesis research framework.

b. Establishing a student development construct in undergraduate vocational universities.

This thesis applied the FDT to establish a five level student development construct for undergraduate vocational universities based on relevant literature, combined with expert panel discussions and expert surveys. Previous scholars' studies have similarities with this thesis. For example, the dimensional

divisions of student developmental constructs such as knowledge, ability, value, and social development have been promoted by many scholars. However, the differences are also noticeable, as they focus more on studying students' own or external influences on student development. Therefore, their studies involve several specific student development indexes and simplified content. The indexes designed in this thesis are comprehensive and relevant and are determined by the characteristics of Chinese undergraduate vocational universities. For example, such universities emphasize developing students' vocational and operational abilities to solve practical problems in their jobs. In particular, indexes of professional quality, professional ability, and career development ability are a priority that must be given to undergraduate vocational universities over other universities.

The results of index screening show that the expert consensus degree of the three deleted indexes is below 4.5. The consensus degree of the retained indexes is above 7.6, which fully indicates that the experts evaluate the importance degree of the indexes with high consistency. The reliability of the indexes is high, probably because: 1. The researcher invited six experts to participate in the initial design of the indexes and solicited 22 experts' opinions on the improvement of the indexes related to repeated consultations to improve the rationality and reliability of the indexes. 2. Applying the FDT overcomes the subjective ambiguity of humans in the screening of student development indexes and improves the reliability of the indexes. 3. AHP to assign index weights considers the hierarchical nature and interrelationship of the student development construct, making the weight assignment more scientific and

reasonable. Notably, the consensus value of experts when applying the FDT for screening indexes matches the ranking of importance when applying AHP for assigning index weight, which again indicates that the indexes designed in this thesis are highly reliable.

The weight of the indexes shows that quality development is the most critical concern of the experts, and ability is more important than knowledge. The above results align with the Chinese MOE's recent proposal of "virtue first, ability focused, and knowledge-based" as the standard for training talents. It further indicates the focus of attention and emphasis on university and student development. It also shows that the student development construct designed in this thesis may not apply to other countries. Still, it is consistent with China's national conditions and the requirements of talent training in undergraduate vocational universities. It also fully reflects the characteristics of running a socialist university with Chinese characteristics.

c. Developing a student development survey instrument for undergraduate vocational universities

Based on the student development construct designed in this thesis, the researcher developed the empirical survey instrument-the Chinese Undergraduate Vocational University Student Development Survey Instrument. Then, AHP was applied to determine the weights of indexes at each level, and SPSS was used to test the reliability and validity, and the test results were good. To our knowledge, the student development construct designed in this thesis is the first set of "Student Development Construct of Chinese Undergraduate

Vocational Universities" indexes applied to Chinese universities. This thesis's empirical student development data are China's most recent student assessment results. It fills a gap in theoretical research on undergraduate vocational education and student development and provides a clear direction for student development in undergraduate vocational universities.

d. Analysis and evaluation of student development index levels

This thesis applied SPSS software to analyze the overall student development index level and also compared and analyzed that of students by gender, subject, grade, and university. The results of the empirical study show that male students develop at a higher level than female students, sciences students at a higher level than arts students, and the highest level of development in the fourth grade, consistent with other scholars' findings. This thesis's empirical research data on student development are also China's most recent student assessment results. However, student development in undergraduate vocational universities also shows uniqueness. There is a stagnation or decline in some index development of third-grade students. This result can be explained by Kenneth's study "The Impact of College on Students". There is a large gap between the reality of "quality-based and ability-focused" requirements of undergraduate vocational universities and that students' quality development increases the least, and their ability development increases less than their knowledge development in the four years of university. This thesis differs from the previous evaluation of education quality from the perspective of university inputs. This research proposed to evaluate the quality of talent cultivation from the perspective of student development outcomes,

which can help provide new perspectives and new thinking for China's education evaluation reform.

e. To propose countermeasures and suggestions for improving student development level

This thesis addresses the current shortcomings in the process of improving the quality of talent development in Chinese undergraduate vocational education, in conjunction with the results of this thesis's empirical analysis, and makes several suggestions for improving student development in Chinese undergraduate vocational universities: focus on all students to enhance their overall development; balance different dimensions to promote all-round development; narrow the group gap to encourage the development of all members. It can provide fresh ideas for vocational education departments and universities to develop effective educational measures or adopt appropriate reforms to help universities produce the high-quality tech talents that China desperately needs as soon as possible.

6.2 Research Innovation

Innovation in research topic selection. Undergraduate vocational universities are the product of China's commitment to high-quality and high-efficiency socio-economic development in recent years, and these universities are new in China. It is easy to find from the relevant literature that student development in undergraduate vocational universities in China is a gap in academic research. This thesis on the construct and evaluation of student

development filled this research gap, which is of great practical significance for the current clarification of student development goals and objective evaluation of student development level in undergraduate vocational universities.

Innovation of research ideas. This thesis reviews the research literature related to OBE theory and its application and student development. Researchers in China and other countries have widely applied OBE theory to many aspects of education research. However, throughout the previous studies, no research related to applying OBE theory to student development has been involved. Applying OBE theory to guide the system design of student development research in undergraduate vocational universities is a new research idea. It is also an application innovation and practical exploration of OBE theory.

Innovation from a research perspective. This thesis is no longer limited to the traditional method of evaluating student development by academic achievement and other methods. Still, it fully uses the student development instrument designed for this thesis. It is a self-evaluation of student development based on students' responses to learning and development questions, emphasizing students' self-perceived development. This thesis analyzes and compares student development in general, between individuals and elements, and between different groups. It evaluates student development

level in a comprehensive and multidimensional way, providing a new perspective for undergraduate vocational universities to conduct student development evaluation better.

6.3 Limitations and Prospects

Based on the student development perspective, this thesis has done some empirical research on student development in undergraduate vocational universities in China. Still, due to the limitations of the researcher's vision and ability, this thesis has the following shortcomings that deserve further research by more researchers.

First, the evaluation index system constructed is not empirically verified. In the data analysis, the experts have higher authority and more focused opinions, and the designed indexes have a certain degree of scientificity. However, this thesis is still in the stage of academic research, and the constructed index system has not been applied to actual student development. In the future, the results of this thesis will be used for the actual status, and the indexes will be revised again to maximize the adaptation to the actual needs and achieve the objective and accurate purpose.

Second, the number of experts is not balanced, and the weight of their opinions is not considered. The respondents of this thesis are experts from

different fields, and the number of them in each area is not equal, and their positions and opinions may be divergent. However, they all belong to the decision-making group. Therefore, future research could consider the number of survey experts from different fields and weigh their relative importance to make the findings more scientific.

Third, the time for student development evaluation is limited. The educational cycle in undergraduate vocational universities is four years, and due to the limited time available for research and evaluation, the researcher collected data on student development in four grades over the same period and only comparatively analyzed the developmental level of overall and different groups of students. In future studies, scholars could also follow students in one grade longitudinally. Analyze and compare the trajectory of their development indexes over the four years of college, and deeply analyze and explore student development patterns and characteristics.

In response to the above shortcomings, in future work practice, the researchers will continue to conduct further relevant studies to enhance the theoretical support of this thesis, improve the depth of problem understanding, and refine and improve the student development planning of undergraduate vocational education.

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APPENDICES

Appendix A

Survey Approval for Shandong Vocational and Technical University of Engineering

山东工程职业技术大学
Shandong Vocational and Technical University of Engineering

Universiti Tunku Abdul Rahman:

The Student Affairs Office of Shandong Vocational and Technical University of Engineering received an application from a Ph.D student of your faculty, Xing Qiaona (Passport No: EJ1583726) on November 23, 2021, about the need to conduct field research and data analysis at our university. We learned that she would have several rounds of consultation with our experts, conduct a survey on our students, and complete the data analysis from March 1, 2022 to March 1, 2023.

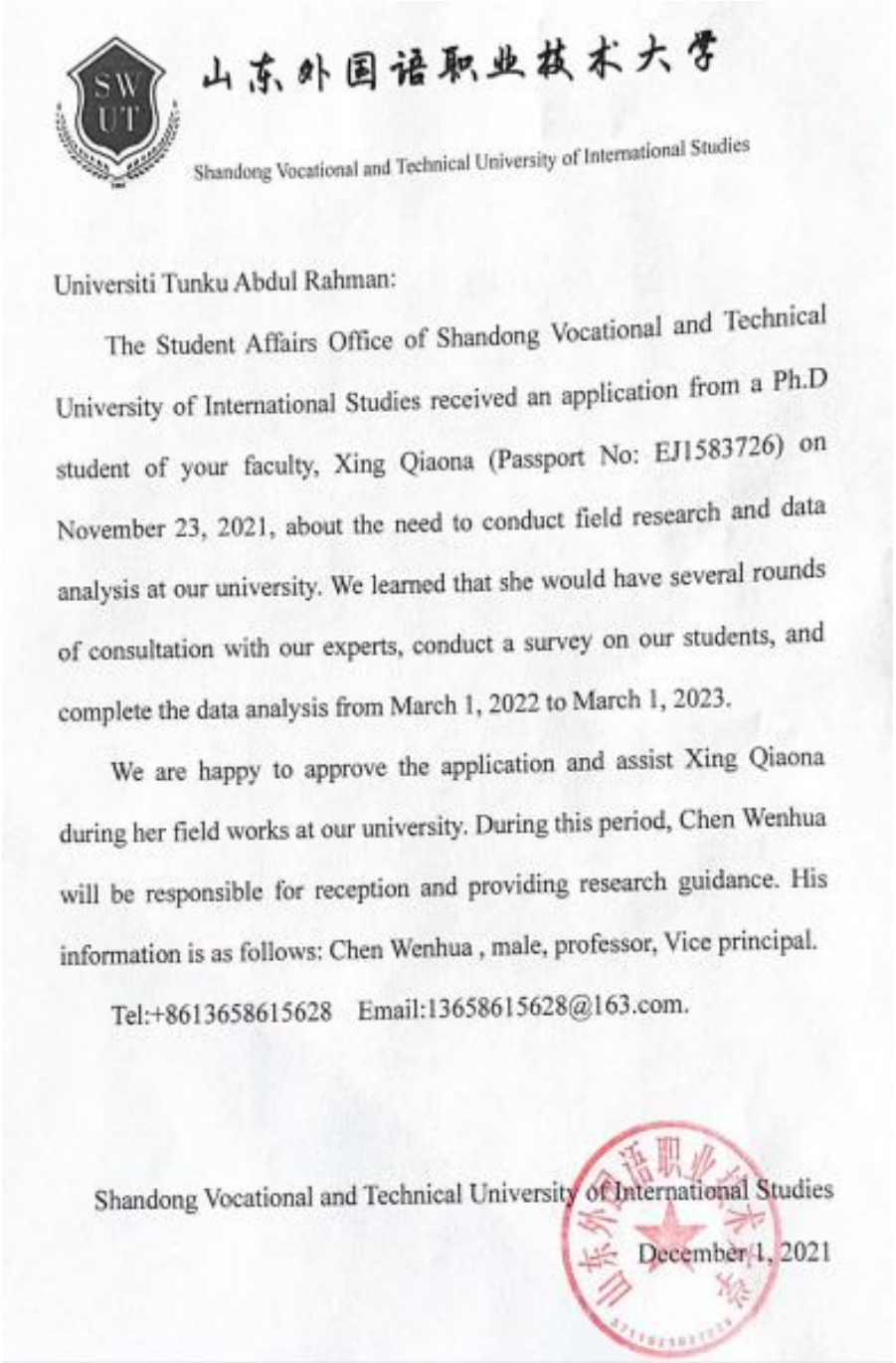
We are happy to approve the application and assist Xing Qiaona during her field works at our university. During this period, Su Liyou will be responsible for reception and providing research guidance. His information is as follows: Su Liyou, male, associate professor, executive dean of the School of Modern Art. Tel:+86053180958177, Email: 68781602@qq.com.

Shandong Vocational and Technical University of Engineering

December 1, 2021

Appendix B

Survey Approval for Shandong Vocational and Technical University of International Studies



山东外国语职业技术大学

Shandong Vocational and Technical University of International Studies

Universiti Tunku Abdul Rahman:

The Student Affairs Office of Shandong Vocational and Technical University of International Studies received an application from a Ph.D student of your faculty, Xing Qiaona (Passport No: EJ1583726) on November 23, 2021, about the need to conduct field research and data analysis at our university. We learned that she would have several rounds of consultation with our experts, conduct a survey on our students, and complete the data analysis from March 1, 2022 to March 1, 2023.

We are happy to approve the application and assist Xing Qiaona during her field works at our university. During this period, Chen Wenhua will be responsible for reception and providing research guidance. His information is as follows: Chen Wenhua , male, professor, Vice principal.

Tel:+8613658615628 Email:13658615628@163.com.

Shandong Vocational and Technical University of International Studies

December 1, 2021

Appendix C

Survey Approval for Shandong Vocational University of Foreign Affairs

山东外事职业大学校

Shandong Vocational University of Foreign Affairs

Universiti Tunku Abdul Rahman:

The Student Affairs Office of Shandong Vocational University of Youth League Committee received an application from a Ph.D student of your faculty, Xing Qiaona (Passport No: EJ1583726) on November 23, 2021, about the need to conduct field research and data analysis at our university. We learned that she would have several rounds of consultation with our experts, conduct a survey on our students, and complete the data analysis from March 1, 2022 to March 1, 2023.

We are happy to approve the application and assist Xing Qiaona during her field works at our university. During this period, Ma Chengjie will be responsible for reception and providing research guidance. His information is as follows: Ma Chengjie, male, member of the Youth League Committee of Shandong Vocational University of Foreign Affairs. Tel: +8613406722015，Email: 351580249@qq.com.

Shandong Vocational University of Foreign Affairs

December 1, 2021

Appendix D

Survey Approval for Universiti Tunku Abdul Rahman

UNIVERSITI TUNKU ABDUL RAHMAN
Institute of Postgraduate Studies and Research

Date: 09/02/2022

Xing, Qiaona
21AAD00364

Notice: Approval of Research Attachment

This is to notify that Senate at its meeting on 09/02/2022 has approved your application as follows:-

Attachment at: Shandong Vocational and Technical University of International Studies, Shandong Vocational and Technical University of Engineering, and Shandong Vocational University of Foreign Affairs, China
Category : Research Attachment
Duration: 1 March 2022 - 1 February 2023

Please note on the following:-

(a) Those under Research Attachment you are required to report on your research progress and continue to register for courses at the start of each trimester at UTAR during your period at Shandong Vocational and Technical University of International Studies, Shandong Vocational and Technical University of Engineering, and Shandong Vocational University of Foreign Affairs, China.
(b) Schedule the research progress presentation through video conferencing with your supervisor(s) as per the agreed research plan.
(c) Those under Mutual Credit Recognition are required to register for courses at the Host Institution and report to the HoP for credit transfer once completed the courses.
(d) International candidates should ensure their Student Visa is valid at all times.

If you have any further queries, please contact our officer or e-mail hllim@utar.edu.my.

This is a computer generated document no signature is required
No Alteration or Addition is hereby authorise

Appendix E

Interview Outline for Vocational Education Policymakers

1. Do you think China's current talent construct meets the needs of economic and social development?

2. Are there a gap between high-quality tech talents in China?

3. Can the current Chinese vocational education meet China's demand for high-quality tech talents?

4. Is China currently adopting active policies to promote the development of China's vocational education?

5. What aspects of vocational education are being focused on in the measures taken?

6. What is the actual effect of this measure?

7. Does the education department's policy include content promoting student development? If so, what is the effect?

8. Does the education department have a monitoring and evaluation system for the student development level? If so, what is the effect?

9. Do you think using the student development construct to evaluate the student development level is effective? If it is effective, are you willing to consider introducing the evaluation mechanism of the student development construct in formulating the policy?

Appendix F

Interview Outline for Undergraduate Vocational Education Talent Training Goal Makers

1. In your opinion, what qualities should China's high-quality tech talents include?

2. Does your university's talent development program currently match the development and improvement of your student's ability structure?

3. What areas do your students have solid abilities or qualities in? It is due to the high implementation of what content in the talent training goal?

4. Are you clear about the future employment direction of your university students?

5. Has your university conducted relevant surveys on the demand for talent in this industry? If so, can your university's talent training quality meet the corresponding requirements?

6. Has your university surveyed the employers in the industry? If so, how long will it take for new students in the industry to adapt to the job requirements?

7. Do you think your university's talent training goals are not perfect? If so, which one or several aspects?

8. Has your university evaluated and surveyed the student development level? If so, what method was adopted? How is the effect?

9. Do you think universities should pay more attention to student development? If so, which way would you like to understand the student development level?

10. Are you interested in the student development construct? If it is verified that the construct is valid, would you like to use it in your university?

Appendix G

Interview Outline for Undergraduate Vocational University Students

1. Which undergraduate vocational university do you study at? What is your major? What grade are you in now?

2. How did you enter the undergraduate vocational university?

3. Are you interested in the major you are studying? Do you know the counterpart employment industry of this major?

4. Does your university offer theoretical and practical courses? If so, what is the ratio of the two?

5. Does your university have student clubs? If so, is the student clubs helpful to significant learning? Which club did you join?

6. Do you have a clear plan for your future career development? If so, what preparations have you made for your future career development?

7. Does your university carry out professional practice or internship activities? If so, what methods have been adopted to evaluate the internship results?

8. Besides the exam, does your university have other evaluation indexes? If so, what aspects are covered?

9. Do you understand what abilities undergraduate vocational university students should have and your current development level?

Appendix H

Expert Consultation Questionnaire on Student Development Construct Indexes in Undergraduate Vocational Universities-Index Refinement

Dear experts，

I am Qiaona Xing, a Ph.D. student in Philosophy (Social Science) at Universiti Tunku Abdul Rahman, Malaysia. I am researching “Applying Fuzzy Delphi Technique to design student development construct in undergraduate vocational universities”.

This thesis has a distinctive problem orientation. It focuses on developing vocational education in China in response to the shortage of high-quality tech talents in economic transformation and industrial upgrading in recent years. It is dedicated to “how to design the student development in undergraduate vocational universities” and “what core qualities and abilities should be cultivated in undergraduate vocational education”.

In this thesis, the undergraduate vocational university student developmental construct refers to the knowledge, ability, and quality that Chinese undergraduate vocational university students should possess after completing their university-level studies. It refers to what students have learned and what they can do when they graduate. This thesis aims to design a

student development construct for undergraduate vocational universities, which refers to the specific knowledge, ability, and quality students must have by the time they graduate.

It is a theoretical guide for designing and implementing student development in undergraduate vocational universities. It will help them improve the talent training quality and cultivate talents aligned with China's economic and social development.

This thesis initially drew up an undergraduate vocational university student developmental construct after a preliminary study (as shown in the table below). This consultation explores what knowledge, ability, and quality undergraduate vocational university students should possess upon graduation based on the goals and characteristics of talent training in undergraduate vocational education. Experts are invited to provide comments and suggestions on modifying, retaining, merging, and adding to the student development construct indexes listed in Table 1 to improve further the student development construct of undergraduate vocational universities designed in this thesis and provide scientific theoretical guidance and data support for undergraduate vocational universities to cultivate high-quality tech talents who meet the needs of social and economic development.

It is a great honor to invite you as the consulting expert for this thesis. Your comments or suggestions will significantly help the successful completion of this thesis. With your valuable opinions, I hope we can jointly discuss a scientific and reasonable undergraduate vocational education student development construct. Thank you for your help and support. I am very grateful!

Xing Qiaona, a Ph.D. candidate at UTAR University

April 2021

Preliminary Designed Undergraduate Vocational Education Student Development Construct：

Goal (1st-level index)	Element (2nd-level index)	Dimension (3rd-level index)	Factor (4th-level index)	Index (5th-level index)
student development	cognitive development	knowledge development	general knowledge	extensive coverage of relevant
				learn about science
				learn about the humanities
				learn about art
			professional knowledge	professional basic knowledge
				deep professional theoretical
				professional technical application
		ability development	general ability	good oral presentation ability
				well-written expression ability
				foreign language application
				proficiency in the application of
				organizational leadership ability
				ability to cooperate effectively
				self-learning ability
			professional ability	job adaptability
				post operation ability
				ability to solve problems on the job
				ability to innovate professional
			career development ability	career planning ability
				career changeability
				career mobility ability
				career advancement ability
	non-cognitive development	value development	value	establishment of value
				personal outlook on the world and
				understanding of the culture and
				self-awareness
		quality development	personal quality	personal character
				physical and mental health
				sense of responsibility
				professional ethics
			professional quality	competitive awareness
				reverse thinking
				craftsman spirit

Completion instructions：

1. This thesis considers what knowledge, ability, and quality undergraduate vocational university students must have when they graduate. The consultation results on student development construct indexes for undergraduate vocational universities will be used to reverse the design of

student development pathways and evaluation systems. The purpose of this consultation is to determine: the rationality and appropriateness of the developmental construct of students in undergraduate vocational universities.

2. Please fill in your familiarity with undergraduate vocational education students' development construct indexes and your judgment based on the actual situation.

3. You are invited to review the preliminary construct indexes for student development in undergraduate vocational education designed in this thesis. If you have any comments on modifying, reserving, or combining the indexes, please indicate the category in the "Disposal comments" column and fill in the "Expert comments and suggestions" column. If you wish to add a new index, please enter the new number, the content of the index, and the reason for the addition in the "New index" field.

Part I Background information

1. Your title: ☐Professor ☐Associate Professor ☐Lecturer ☐Other__

2. Your position ( )

3. Number of years in your current position: ☐Less than 1 year ☐1-5 years ☐6-9 years ☐10-15 years ☐16-20 years ☐More than 20 years

4. Your age: ☐ 30-40 years old ☐ 40-50 years old ☐ 50 years old or above

5. Your degree: ☐ Specialist ☐ Bachelor ☐Postgraduate ☐Doctorate

Part II Basis for judgment

1. How familiar are you with the undergraduate vocational education student development construct indexes?

☐ Very familiar ☐ Quite familiar ☐ Generally familiar ☐ Not very familiar ☐Very unfamiliar

2. The extent to which your judgment of the construct indexes of student development in undergraduate vocational education is influenced by the following factors.

Practical experience: ☐ Highly influential ☐ Generally influential ☐ Generally familiar

Logical reasoning: ☐ Highly influential ☐ Generally influential ☐ Generally familiar

Knowledge of national and international: ☐Highly influential ☐Fairly influential ☐Fairly familiar

Intuition: ☐High impact ☐Average impact ☐Average familiarity

Part Ⅲ Expert consultation on student development construct indexes in undergraduate vocational universities

1. The researcher believes that student development in undergraduate vocational universities consists of two 2nd-level indexes, cognitive and non-cognitive development.

Indexes that need refine					
No.	**Index**	**Disposal comments (modify, retain, merge)**			**Expert comments and suggestions**
1	cognitive development	☐ Modify	☐ Retain	☐ Merge	
2	non-cognitive development	☐ Modify	☐ Retain	☐ Merge	
Indexes that need to be added					
Add number	**Index**	**Reasons for increasing the index**			

2. According to the researcher, the construct indexes of student development in undergraduate vocational universities are divided into knowledge and ability development for cognitive development and value and quality development for non-cognitive development. Do you think this classification or expression is reasonable? Please fill in the table below with your comments on modifications, retaining, mergers, and additions.

Indexes that need perfect					
No.	**Index**	**Disposal comments (modify, retain, merge)**			**Expert comments and suggestions**
1-1	knowledge development	☐ Modify	☐ Retain	☐ Merge	
1-2	ability development	☐ Modify	☐ Retain	☐ Merge	
2-1	value development	☐ Modify	☐ Retain	☐ Merge	
2-2	quality development	☐ Modify	☐ Retain	☐ Merge	
Indexes that need to be added					
Add number	**Index**	**Reasons for increasing the index**			

3. The researcher believes that the four dimensions of knowledge, ability, value, and quality of undergraduate vocational university student development can be further refined. Knowledge is categorized as general and professional knowledge; ability is divided into general, professional, and career development ability; and qualify is categorized as personal and professional. If you think this classification or expression is unreasonable, please fill in the table below with your comments on modifications, retains, mergers, and additions.

Indexes that need perfect					
No.	**Index**	**Disposal comments (modify, retain, merge)**			**Expert comments and suggestions**
1-1-1	extensive coverage of	☐ Modify	☐ Retain	☐ Merge	
1-1-2	learn about science	☐ Modify	☐ Retain	☐ Merge	
1-1-3	learn about the humanities	☐ Modify	☐ Retain	☐ Merge	
1-1-4	learn about art	☐ Modify	☐ Retain	☐ Merge	
1-2-1	general ability	☐ Modify	☐ Retain	☐ Merge	
1-2-2	professional ability	☐ Modify	☐ Retain	☐ Merge	
1-2-3	career development ability	☐ Modify	☐ Retain	☐ Merge	
2-1-1	value	☐ Modify	☐ Retain	☐ Merge	
2-2-1	personal quality	☑ Modify	☐ Retain	☐ Merge	
2-2-2	professional quality	☐ Modify	☐ Retain	☐ Merge	
Indexes that need to be added					
Add number	**Index**	**Reasons for increasing the index**			

4. Based on the Outcomes-Based Education (OBE) theory, student development theory, the needs of social and economic development, the goals and specifications of undergraduate vocational education talent training, and the results of previous research, this thesis develops specific 5th-level indexes for the development construct of students in undergraduate vocational universities. If you think this classification or expression is reasonable, please fill in the table below with your comments on modifications, retains, mergers, and additions.

Indexes that need perfect					
No.	**Index**	**Disposal comments (modify, retain, merge)**			**Expert comments and suggestions**
1-1-1-1	learn about science	☐ Modify	☐ Retain	☐ Merge	
1-1-1-2	learn about the humanities	☐ Modify	☐ Retain	☐ Merge	
1-1-1-3	learn about art	☐ Modify	☐ Retain	☐ Merge	
1-1-1-4	professional basic knowledge	☐ Modify	☐ Retain	☐ Merge	
1-1-2-1	deep professional theoretical knowledge	☐ Modify	☐ Retain	☐ Merge	
1-1-2-2	professional technical application knowledge	☐ Modify	☐ Retain	☐ Merge	
1-1-2-3	good oral presentation ability	☐ Modify	☐ Retain	☐ Merge	
1-2-1-1	well-written expression ability	☐ Modify	☐ Retain	☐ Merge	
1-2-1-2	foreign language application ability	☐ Modify	☐ Retain	☐ Merge	
1-2-1-3	proficiency in the application of information	☐ Modify	☐ Retain	☐ Merge	
1-2-1-4	organizational leadership ability	☐ Modify	☐ Retain	☐ Merge	
1-2-1-5	ability to cooperate effectively with others	☐ Modify	☐ Retain	☐ Merge	
1-2-1-6	self-learning ability	☐ Modify	☐ Retain	☐ Merge	
1-2-1-7	job adaptability	☐ Modify	☐ Retain	☐ Merge	

No.	Index	Disposal comments (modify, retain, merge)			Expert comments and suggestions
1-2-2-1	post operation ability	☐ Modify	☐ Retain	☐ Merge	
1-2-2-2	have the ability to solve problems on the job	☐ Modify	☐ Retain	☐ Merge	
1-2-2-3	possess the ability to innovate professional	☐ Modify	☐ Retain	☐ Merge	
1-2-2-4	emergency handling ability	☐ Modify	☐ Retain	☐ Merge	
1-2-3-1	career planning ability	☐ Modify	☐ Retain	☐ Merge	
1-2-3-2	career changeability	☐ Modify	☐ Retain	☐ Merge	
1-2-3-3	career mobility ability	☐ Modify	☐ Retain	☐ Merge	
1-2-3-4	career advancement ability	☐ Modify	☐ Retain	☐ Merge	
1-3-1-1	establishment of value	☐ Modify	☐ Retain	☐ Merge	
1-3-1-2	personal outlook on the world and life	☐ Modify	☐ Retain	☐ Merge	
1-3-1-3	understand the culture and value of different	☐ Modify	☐ Retain	☐ Merge	
1-4-1-1	self-awareness	☐ Modify	☐ Retain	☐ Merge	
1-4-1-2	personal character	☐ Modify	☐ Retain	☐ Merge	
1-4-1-3	physical and mental health	☐ Modify	☐ Retain	☐ Merge	
1-4-1-4	sense of responsibility	☐ Modify	☐ Retain	☐ Merge	
1-4-2-1	dialectical thinking	☐ Modify	☐ Retain	☐ Merge	
1-4-2-2	professional ethics	☐ Modify	☐ Retain	☐ Merge	
1-4-2-3	craftsman spirit	☐ Modify	☐ Retain	☐ Merge	
1-4-2-4	legal awareness	☐ Modify	☐ Retain	☐ Merge	

Indexes that need to be added

Add number	Index	Reasons for increasing the index

Thank you again for your patience in reviewing and providing valuable comments!

Appendix I

Expert Consultation Questionnaire on Student Development Construct Indexes in Undergraduate Vocational Universities-Screening Indexes

Dear Experts，

Thank you very much for your help in completing this questionnaire out of your busy schedule. It is a questionnaire on screening student development construct indexes in undergraduate vocational education. To make the evaluation indexes identified in the thesis more objective and scientific, I hope to rely on your extensive experience and academic attainment in this field to provide valuable advice through this expert questionnaire. You are invited to evaluate the importance of each index, and your data will be processed to determine the screening of each index using the Fuzzy Delphi Technique (FDT). Your help will greatly assist the researcher in writing the thesis and is greatly appreciated. The information in your completed questionnaire is for academic research and will not be used for any other purpose.

Personal information:

Job title:

Position：

Years in current position：

Age：

Degree：

Completion Instructions：

This questionnaire aims to screen undergraduate vocational education student developmental construct indexes. The questionnaire is designed according to the form of the Fuzzy Delphi Technique. You are invited to evaluate the appropriateness and importance of each index by referring to the following evaluation guidelines. The evaluation is based on a scale of 1-9, with higher scores indicating more significant importance. Please rate the importance of each index according to your professionalism and fill in the integer values. The evaluation of each index consists of two parts.

Importance-evaluate: this index is vital to the upper level of indexes and enters a single integer value.

Acceptability-evaluate: this index's acceptable range of importance to the upper level of indexes and enter the upper and lower acceptable values, respectively.

Evaluation I

Please complete the answer on the level of importance and acceptable range of the 2nd-lever indexes "cognitive and non-cognitive development" concerning the 1st-level index "student development".

	Level of importance	Acceptable range	
2nd-level index	**Single value for your perceived level of importance (1-9)**	**The acceptable minimum value (1-9)**	**The maximum acceptable value (1-9)**
student development (1st-level index)			
cognitive development			
non-cognitive development			

Evaluation Ⅱ

The 2nd-level indexes have sub-indexes, namely the 3rd-level indexes. Please fill in the answers on the importance of them to the 2nd-level indexes and their acceptable importance range.

	Level of importance	Acceptable range	
3rd-level index	**Single value for your perceived level of importance (1-9)**	**The acceptable minimum value (1-9)**	**The maximum acceptable value (1-9)**
Cognitive development (2nd-level index)			
knowledge development			
ability development			
Non-cognitive development (2nd-level index)			
quality development			

Evaluation Ⅲ

The 3rd-level indexes have sub-indexes, namely the 4th-level indexes. Please fill in the answers on the importance of them to the 3rd-level indexes and their acceptable importance range.

	Level of importance	Acceptable range	
4th-level index	**Single value for your perceived level of importance (1-9)**	**The acceptable minimum value (1-9)**	**The maximum acceptable value (1-9)**
Knowledge development (3rd-level index)			
general knowledge			
professional knowledge			
Ability development (3rd-level index)			
general ability			
professional ability			
career development			
Quality development (3rd-level index)			
value			
personal quality			
professional quality			

Evaluation Ⅳ

The 4th-level indexes have sub-indexes, namely the 5th-level indexes. Please fill in the answers as above.

	Level of importance	Acceptable range	
5th-level index	**Single value for your perceived level of importance (1-9)**	**The acceptable minimum value (1-9)**	**The maximum acceptable value (1-9)**
General knowledge (4th-level index)			
learn about science			
learn about the humanities			
learn about art			
Professional knowledge（(4th-level index)			
professional basic knowledge			
deep professional theoretical knowledge			
professional technical application knowledge			
General ability(4th -level index)			
good oral presentation ability			
well-written expression ability			
foreign language application ability			
proficiency in the application of information technology			
organizational leadership ability			
ability to cooperate effectively with others			
self-learning ability			
Professional ability(4th-level index)			
job adaptability			

5th-level index	Single value for your perceived level of importance (1-9)	The acceptable minimum value (1-9)	The maximum acceptable value (1-9)
Professional ability(4th-level index)			
post operation ability			
ability to solve problems on the job			
ability to innovate professional positions			
emergency handling ability			
Career development ability(4th-level index)			
career planning ability			
career changeability			
career mobility ability			
career advancement ability			
Value(4th-level index)			
establishment of value			
personal outlook on the world and life			
understanding of the culture and values of different groups			
Personal quality(4th-level index)			
self-awareness			
personal character			
physical and mental health			
sense of responsibility			
dialectical thinking			
Professional quality(4th-level index)			
professional ethics			
craftsman spirit			
legal awareness			

Appendix J

Expert Consultation Questionnaire on Student Development Construct Indexes in Undergraduate Vocational Universities -Weight Survey

Dear experts,

This questionnaire determines the weight of each index in the student development construct in undergraduate vocational education. The data collected were analyzed using Analytic Hierarchy Process. The hierarchical construct of student development in undergraduate vocational education is presented in the table below.

To make the student development construct indexes proposed in this thesis more objective and scientific, we hope to rely on your extensive experience and academic attainment in this field to provide valuable comments through this expert questionnaire. By comparing the importance of each index to the objective, you will be able to determine the weight of each index. Your help will greatly assist the researcher in writing her thesis and is greatly appreciated. The information you provide in the questionnaire is for academic research and will not be used for any other purpose.

The hierarchical construct of undergraduate vocational education student development:

Goal (1st-level index)	Element (2nd-level index)	Dimension (3rd-level index)	Factor (4th-level index)	Program (5th-level index)
student development	cognitive development (B1)	knowledge development (C1)	general knowledge (D1)	learn about science (E1)
				learn about the humanities (E2)
				learn about art (E3)
			professional knowledge (D2)	professional basic knowledge (E4)
				deep professional theoretical knowledge (E5)
				professional technical application knowledge (E6)
		ability development (C2)	general ability (D3)	good oral presentation ability (E7)
				well-written expression ability (E8)
				foreign language application ability (E9)
				proficiency in the application of
				organizational leadership ability (E11)
				ability to cooperate effectively with
				self-learning ability (E13)
			professional ability (D4)	job adaptability (E14)
				post operation ability (E15)
				have the ability to solve problems on the job (E16)
				possess the ability to innovate professional positions (E17)
				emergency handling ability (E18)
			career development ability (D5)	career planning ability (E19)
				career changeability (E20)
				career mobility ability (E21)
				career advancement ability (E22)
	non-cognitive development (B2)	quality development (C3)	value (D6)	establishment of value (E23)
				personal outlook on the world and life (E24)
				understand the culture and values of different groups (E25)
			personal quality (D7)	self-awareness (E26)
				personal character (E27)
				physical and mental health (E28)
				sense of responsibility (E29)
				dialectical thinking (E30)
			professional quality (D8)	professional ethics (E31)
				craftsman spirit (E32)
				legal awareness (E33)

Personal information:

Job title:

Position：

Years in current position：

Age：

Degree：

Completion instructions:

This questionnaire is an Analytic Hierarchy Process questionnaire. This method compares the importance of two indexes at the same level against the upper level. Please rank the indexes in order of importance as listed, then compare each two indexes later to select their significance.

Part I Ranking the importance of 2nd-level indexes

1. Importance ranking

For student development indexes, the relative importance of **(1) cognitive development** and **(2) non-cognitive development**:

Ranking of the degree of importance of the two indexes: ( ) ≥ ( ) (please fill in the numbers).

2. Every two indexes comparative evaluation

Absolutely important (9), very important (7), relatively important (5),

slightly important (3), equally important (1), 8, 6, 4, 2, indicate the middle of two critical levels.

Measures to the left index that the indexes in the left column are more important than those in the right column, and those to the right index that the indexes in the right column are more important than those in the left column. Tick " √ " the corresponding box according to your opinion.

Example: If you think that index A, "Cognitive development," on the left is absolutely important compared to index B, "Non-cognitive development," on the right, then mark " √ " in column 9 on the left. If you think that "Cognitive development" should be significant compared to "Non-cognitive development", then you can mark " √ " in column 9 on the right.

Index A	Left side is absolutely important		Left side is very important		Left side is more important		Left side is slightly important	Both are equally important	Right side is slightly important		Right side is more important		Right side is very important		Right side is absolutely important	Index B
	9	8	7	6	5	4	3	1	2	3	4	5	6	7	8	9	
cognitive development																	non-cognitive development

Part Ⅱ　Ranking the importance of 3rd-level indexes

1. Importance ranking

For student development indexes, the relative importance of **(1) knowledge development** and **(2) ability development:**

Ranking of the degree of importance of the two indexes: ( ) ≥ ( ) (please fill in the numbers).

2. Every two indexes comparative evaluation

Index A	Left side is absolutely important		Left side is very important		Left side is more important		Left side is slightly important		Both are equally important		Right side is slightly important		Right side is more important		Right side is very important		Right side is absolutely important	Index B
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
knowledge development																		ability development

Part Ⅲ Ranking the importance of 4th-level indexes

1. Knowledge development aspect

Importance ranking. For knowledge development, the relative importance of the indexes of **(1) general knowledge and (2) professional knowledge.**

Ranking of the degree of importance of the two indexes: ( ) ⩾ ( ) (please fill in the numbers).

Each two indexes comparative evaluation:

Index A	**Left side is absolutely important**		**Left side is very important**		**Left side is more important**		**Left side is slightly important**		**Both are equally important**		**Right side is slightly important**		**Right side is more important**		**Right side is very important**		**Right side is absolutely important**	**Index B**
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
general knowledge																		professional knowledge

2. Ability development aspect

Importance ranking. For ability development, the relative degree of importance of the indexes of **(1) general ability**, **(2) professional ability,** and **(3) career development ability**:

Ranking of the degree of importance of the three indexes: ( ) ⩾ ( ) ⩾ ( ) (please fill in the numbers).

Every two indexes comparative evaluation:

Index A	**Left side is absolutely important**		**Left side is very important**		**Left side is more important**		**Left side is slightly important**		**Both are equally important**		**Right side is slightly important**		**Right side is more important**		**Right side is very important**		**Right side is absolutely important**	**Index B**
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
general ability																		professional knowledge
general ability																		career development ability
professional ability																		career development ability

3. Quality development aspect

Importance ranking. For quality development, the relative degree of importance of indexes of **(1) value, (2) personal quality, and (3)**

professional quality:

Ranking of the degree of importance of the three indexes: ( ) ⩾ ( ) ⩾ ( ) (please fill in the numbers)

Every two indexes comparative evaluation:

Index A	**Left side is absolutely important**		**Left side is very important**		**Left side is more important**		**Left side is slightly important**		**Both are equally important**		**Right side is slightly important**		**Right side is more important**		**Right side is very important**		**Right side is absolutely important**	**Index B**
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
value																		personal quality
value																		professional quality
personal quality																		professional quality

Appendix K

Student Development Questionnaire for Undergraduate Vocational Universities

Dear students,

To discover how you have developed your knowledge, abilities, and qualities at university. We invite you to participate in this anonymous survey. The results will only be used for academic research. Participation in this survey will help improve the quality of student development in China's undergraduate vocational universities. We sincerely thank you for your support and wish you all the best in your future studies and life!

Personal information (please use the complete name for all information):

College:

Grade:

Major:

Gender:

Questionnaire content:

The following 33 questions reflect your knowledge, ability, and quality development from when you started university to the present stage. Please

answer the questions according to your actual situation. 5 means you have "improved very much," 4 means "improved a lot", 3 means "improved general", 2 means "improved very little" and 1 means "improved almost nothing".

Part I Knowledge development

Measurement items	Options				
	Improved very much	**Improved a lot**	**Improved general**	**Improved very little**	**Improved almost nothing**
learn about science					
learn about the humanities					
learn about art					
professional basic knowledge					
deep professional theoretical knowledge					
professional technical application knowledge					

Part II Ability development

Measurement items	Options				
	Improved very much	**Improved a lot**	**Improved general**	**Improved very little**	**Improved almost nothing**
good oral presentation ability					
well-written expression ability					
foreign language application ability					
proficiency in the application of information technology					
organizational leadership ability					
ability to cooperate effectively with others (E12)					
self-learning ability					
job adaptability					
post operation ability					
have the ability to solve problems on the job					

Measurement items	Improved very much	Improved a lot	Improved general	Improved very little	Improved almost nothing
possess the ability to innovate professional positions					
emergency handling ability					
career planning ability					
career changeability					
career mobility ability					
career advancement ability					

Part III Quality development

Measurement items	Options				
	Improved very much	Improved a lot	Improved general	Improved very little	Improved almost nothing
establishment of value personal outlook on the world and life					
understand the culture and values of different groups					
self-awareness					
personal character					
physical and mental health					
sense of responsibility					
dialectical thinking					
professional ethics					
craftsman spirit					
legal awareness					

Appendix L

Summary of Weight Value of Student Development Construct Indexes in Undergraduate Vocational Universities

Expert Number	Cognitive development B1	Non-cognitive development B2	Cognitive development B1		Knowledge development C1		Ability development C2			Quality Development C3		
			Knowledge development C1	Ability development C2	General Knowledge D1	Professional knowledge D2	General ability D3	Professional ability D4	Career development ability D5	Value D6	Personal quality D7	Professional quality D8
	0.33	0.667	0.67	0.33	0.33	0.67	0.11	0.31	0.58	0.50	0.25	0.25
1	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10	
	0.50	0.50	0.20	0.80	0.20	0.80	0.07	0.49	0.440	0.55	0.21	0.24
2	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.01$ CR=0.01<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10	
	0.33	0.67	0.33	0.67	0.25	0.75	0.07	0.23	0.70	0.55	0.24	0.21
3	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10	
	0.75	0.25	0.50	0.50	0.33	0.67	0.07	0.28	0.64	0.33	0.33	0.33
4	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.07$ CR=0.06<0.10			$\lambda_{max} = 3.00$ CR=0<0.10	
	0.50	0.50	0.25	0.75	0.50	0.50	0.12	0.41	0.48	0.49	0.31	0.20
5	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.03$ CR=0.05<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10	
	0.50	0.50	0.25	0.75	0.67	0.33	0.29	0.14	0.57	0.55	0.24	0.21
6	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10	
	0.50	0.50	0.25	0.75	0.20	0.80	0.16	0.25	0.59	0.33	0.33	0.33
7	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10			$\lambda_{max} = 3.00$ CR=0<0.10	

Expert Number	Cognitive development B1	Non-cognitive development B2	Knowledge development C1	Ability development C2	General Knowledge D1	Professional knowledge D2	General ability D3	Professional ability D4	Career development ability D5	Value D6	Personal quality D7	Professional quality D8
	0.25	0.75	0.33	0.67	0.33	0.67	0.08	0.29	0.63	0.49	0.31	0.20
8	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.10$ CR=0.09<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10	
	0.67	0.33	0.17	0.83	0.67	0.33	0.12	0.32	0.56	0.55	0.24	0.21
9	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10	
	0.75	0.25	0.50	0.50	0.33	0.67	0.16	0.30	0.54	0.58	0.23	0.19
10	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.01$ CR=0.01<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10	
	0.50	0.50	0.33	0.67	0.33	0.67	0.09	0.29	0.62	0.33	0.33	0.33
11	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10	
	0.25	0.75	0.20	0.80	0.20	0.80	0.12	0.32	0.56	0.411	0.32	0.26
12	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.1			$\lambda_{max} = 3.05$ CR=0.05<0.1	
	0.67	0.33	0.33	0.67	0.50	0.50	0.12	0.32	0.56	0.55	0.24	0.21
13	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10	
	0.50	0.50	0.33	0.67	0.25	0.75	0.11	0.31	0.58	0.50	0.25	0.25
14	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10			$\lambda_{max} = 3.10$ CR=0.09<0.10	
	0.50	0.50	0.50	0.50	0.25	0.75	0.07	0.28	0.64	0.41	0.32	0.26
15	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.07$ CR=0.06<0.1			$\lambda_{max} = 3.05$ CR=0.05<0.1	
	0.50	0.50	0.25	0.75	0.50	0.50	0.12	0.41	0.48	0.33	0.33	0.33
16	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.03$ CR=0.05<0.10			$\lambda_{max} = 3.00$ CR=0<0.10	

Expert Number	Cognitive development B1	Non-cognitive development B2	Knowledge development C1	Ability development C2	General Knowledge D1	Professional knowledge D2	General ability D3	Professional ability D4	Career development ability D5	Value D6	Personal quality D7	Professional quality D8
	0.67	0.33	0.33	0.67	0.25	0.75	0.07	0.49	0.44	0.50	0.25	0.25
17	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.01$ CR=0.03<0.10			$\lambda_{max} = 3.10$ CR=0.09<0.10	
	0.50	0.50	0.25	0.75	0.50	0.50	0.11	0.31	0.58	0.58	0.2341	0.19
18	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10	
	0.25	0.75	0.33	0.67	0.25	0.75	0.11	0.31	0.58	0.49	0.31	0.20
19	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.00$ CR=0<0.10			$\lambda_{max} = 3.05$ CR=0.05<0.10	
	0.50	0.50	0.33	0.67	0.50	0.50	0.12	0.32	0.56	0.33	0.33	0.33
20	$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10		$\lambda_{max} = 2.00$ CR=0<0.10			$\lambda_{max} = 3.02$ CR=0.02<0.10			$\lambda_{max} = 3.00$ CR=0<0.10	