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Challenges in application of German higher vocational education mechanism in Chinese School-enterprises

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Abstract

This research study examined the historical development, implementation institutions, teaching models, and other aspects of German higher vocational education (HVE) in relation to the adoption of School-enterprise (S-E) cooperation in the Chinese HVE. The evidence was collected through feedback, evaluation indexes and weights of the effectiveness of the "dual system" that is the backbone of S-E collaboration in vocational education. In order to test the practicability, reliability, stability, and operability of the evaluation model, for the feasibility of research, the "dual-system" of S-E cooperation in the Chinese higher vocational colleges was selected as the subject of this research. The objective was to test the effectiveness of the S-E cooperation in vocational education running in China. A comprehensive evaluation index system for the point of S-E cooperation in vocational education in China was constructed. It was supported by fuzzy evaluation method of S-E collaboration in the Chinese vocational education. The scale collected self-evaluation data and used the fuzzy comprehensive evaluation model to measure the extent of the S-E cooperation in China's vocational education. It was evident due to the varying differences between Germany and China. It was too difficult to adopt the German model of S-E cooperation in the Chinese vocational school unless an innovative approach was adopted. The study recommends adopting innovative measures and customizing the HVE programs in accordance with the Chinese socio-cultural practices and individual requirements of individual students.

Keywords: HVE Germany, S-E cooperation, Effectiveness, Evaluation index system

Higher vocational education (HVE) belongs to the category of high education enjoying a special position and status (Xu Y, 2019). It is a social practice activity aimed at cultivating skilled and application-oriented senior talents who learn a specific vocational skill. It is thus an advanced stage of vocational education (Wei Y, 2018; Rozakis & Borek, 2018; Loyrinic, 2018). There is no proper term for HVE in the German education system and it has three levels equivalent to the three levels of primary, secondary, and higher education in China (Zhao X, 2019). However, from a horizontal perspective, the German education system is divided into two systems: general education and vocational education. In contrast with the Chinese definition of HVE, the German general education system is merely the part of the intersection of its tertiary education while the vocational education system is akin to the post-high school vocational education in China (Mu H, 2020; De Jesus Gutierrez & Castro, 2019; Kartal, 2019; Bichi, 2019; Marvelous et al., 2019; Kilic et al., 2019; Iwegbunam & Robinson, 2019; Mohasoa & Mokoena, 2019; Galatti, 2019).

The School-enterprise(S-E) cooperative education refers to providing the society with high-quality workers who are competent in their job, who can use resources to carry out cooperation between schools and enterprises and other related institutions through classroom teaching. When combined with practical training, S-E cultivates technical and application-oriented graduates with professional and innovation capabilities suitable for different employers' needs and strong enough to promote their social and economic status (J., 2019; Balbag & Kaya, 2019). The S-E cooperation in HVE mainly has following two connotations: first, S-E cooperation is implemented at the higher education stage and does not have the nature of vocational education (Z., 2019); second, S-E cooperation is based on three institutions: enterprise departments, schools, and cooperative education units. S-E cooperation represents all these three institutions and provides a legal basis and guarantee to students. It follows suitable arrangements and regulations of each institution in a specific organizational form, either as an educational model of theoretical teaching or a practical training enterprise (Lin Z, 2019).

The experience of developing HVE in developed countries can be summarized in one sentence: S-E cooperation runs through the whole process of HVE. The HVE in foreign nations mainly presents three different modes: first is the S-E cooperation mode based on enterprises; its representatives are the famous "dual system" in Germany and Japan's government-industry-university cooperation. The second is a school-based S-E cooperation model; its representative is the US cooperative education model which aims to cultivate comprehensive capabilities (Ren, 2018). The third is an industry-led model represented by Australia's model, where industry plays a pivotal role in vocational education (Tian J, 2020).

Regardless of the mode, HVE in developed countries has following common characteristics: first, they have significant S-E cooperation manifested as an enterprise or an internship base for production and teaching (He, 2019). They are responsible for training and acquisition of necessary vocational skills. They provide human, material, and financial guarantees for the implementation of S-E cooperation, and are one of the organizers and

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implementers of S-E collaboration. Secondly, schools also play an essential role in S-E collaboration. The primary manifestation is that schools are places for students to implement general primary education. By imparting basic professional knowledge, enterprises carry out production practice teaching to lay a theoretical foundation (Z, 2018). There are also government enterprises that are macro-control, diversified and sufficiently funded with complete legal guarantees (Ling W, 2016). These isntitutions interact with industry and both represent a scientific S-E cooperation.

German "dual system" vocational education experience

The "dual system" vocational education of Germany is a world-recognized model, and its characteristics and methods are widely spread around the world. The Chinese Ministry of Education entered into cooperation with Germany in the early 1980s to implement the "dual system" vocational training pilot project in China (Ling W, 2016). In 1993, the Chinese and the German prime ministers signed a pact for joint vocational education cooperation. According to this agreement, Germany would fund more than 30 vocational education projects in China (Haisheng P, 2016). The Ministry of Education designated six cities, including Wuxi, as pilot cities to launch these vocational educational projects.

In the past, prior to this agreement with Germany, there already existed a "dual system" in China implemented by a few manufacturing and commercial companies. In this “dual system,” the school was a technical school completely attached to the company. The leader of the company was also the leader of the school. All graduates of this school were employed by the company though there was no such mandatory contract between the company and the students. This “dual system” was completely different from the German one (shown in Figure 1). This study attempts to combine the two systems and prepare a synergy of the two "dual systems" to launch vocational education programs in China. For instance, the enterprise training model in the German "dual system" can be borrowed to construct Chinese vocational education model.

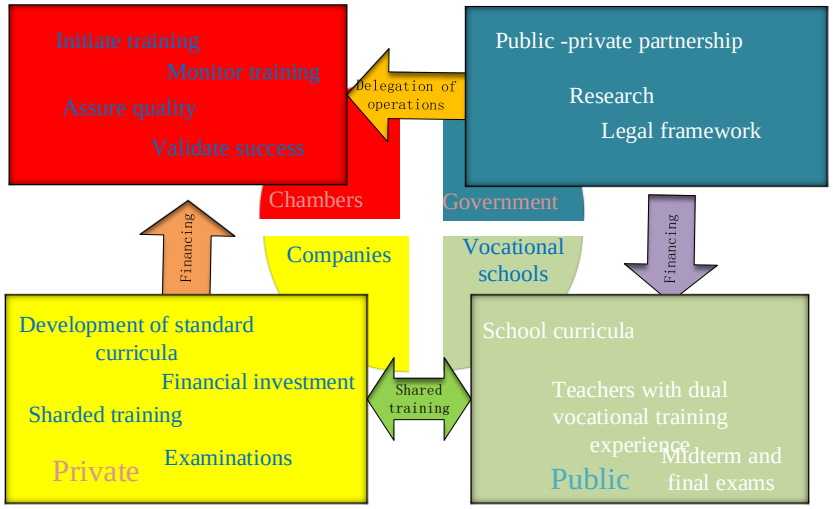

Figure 1. German vocational education system

Problems in vocational education

Due to the economic and employment situation and other factors, vocational education in China has declined in recent years due to which vocational schools have encountered great difficulties. After the year 2000, the vocational and technical education became more severe, with several schools enrolling less than half of their planned enrolment. One of the reasons of low enrolment in some vocational schools was the very unsatisfactory educational level of the junior high school students (Z. Y. , 2018). For instance, in junior high school entrance examination, the total scores of six courses were only 100 points. In some cases, students who had not passed any tests were admitted to the college. Another reason is the lack of implementation of "Vocational Education Law" and many measures for the development of vocational education prescribed by the state (Tiesong Z, 2018). The low enrolment is also due to lack of funds and budget to run full-fledged vocational programs. Education surcharges and subsidies are not enough to meet the vocational education expenses. Business organizations are also not coming forward to help and support vocational education. Teachers' qualification rate in local vocational schools is also lower than that of ordinary middle schools, which results in the shortage of qualified teaching staff, and non-eligibility of teachers in professional courses due to their poor qualification.

The guiding ideology of some vocational schools is not clear enough, and there is a tendency to deviate from the local economic and social reality to varying degrees. The general education model is used from the professional setting to education and teaching, which is out of touch with

the local economic and social needs. The teaching content does not reflect the latest technology. As a result, the experimental practice base's production management level lacks progressive and exemplary nature, and the ability to run schools and self-development is weak. The social influence and attractiveness are not enormous, and the ability to serve the current social and economic development is not healthy. Many vocational school graduates find it is not easy to obtain a job because the knowledge they have learned is out of touch with actual work needs or does not adapt to the region's needs.

Suggestions for vocational education in China based on the German "dual system."

The most desirable aspect of the German "dual system" vocational education is the cooperation between enterprises and vocational-technical schools. When looking for the best way to develop vocational education in China, it is suggested to consider adoption of the German S-E cooperative training model. In Germany, companies offer training positions to trainers to strengthen the "dual system" of vocational education. The company's attitude towards training is positive and they emphasize on preparing the trained workforce for the industry. A similar training system can be adopted in China provided companies participate in vocational education and training voluntarily and actively. They need to understand that if they cooperate with the government's training policies to strengthen the "dual system" of vocational education, it will also benefit them. The graduates trained under the "dual system" are already skilled and trained manpower when they enter the job. They can immediately participate in company's first-line production, manufacturing products, and generating income without any orientation. Companies also need to pay these graduates about one-third of wages that they usually pay to the skilled workers (J., 2019).

It is important to understand how the "dual system works. First of all, companies can set their conditions for recruiting trainers. Any student interested in joining the company and who meets the company's requirements can sign an agreement with the company. The agreement should include: the type and industry the student want to work, the training location, start and end time of training, duration of the probation period, work schedule and office hours, salary and benefits during the training period, leave and rest days, and student's status after graduation. There is a big difference between the dual-systems followed in China and Germany. In China, the number of students who participate in training sessions is quite enormous while the resources and funds and even enterprises are limited. Besides, in China, students are required to pay a tuition fee in order to receive vocational education (Tiesong Z, 2018).

A number of suggestions can be given to establish S-E training under the "dual-system." First and foremost, the enterprise training for students in vocational schools should be free. Students should be paid some stipend during the training period to ensure the smooth functioning of the training. Second, the state should issue guidelines and frame regulations to provide policy support and financial assistance to enterprises that voluntarily establish such training schools. Such enterprises that provide training opportunities to students in vocational schools also contribute to stabilizing the country's economy and national manpower. This helps in improving the overall quality of the country's labor force, and accelerating its industrial growth and modernization. Hence, the state should formulate relevant regulations to protect and support such enterprises (W, 2018). Setting guidelines and support to enterprises will particularly help those enterprises that are unwilling or unable to offer training positions to vocational school students. Once the state provides support and assistance, these companies will voluntarily participate in training of vocational students. The proposed S-E cooperation system is shown in Figure 2.

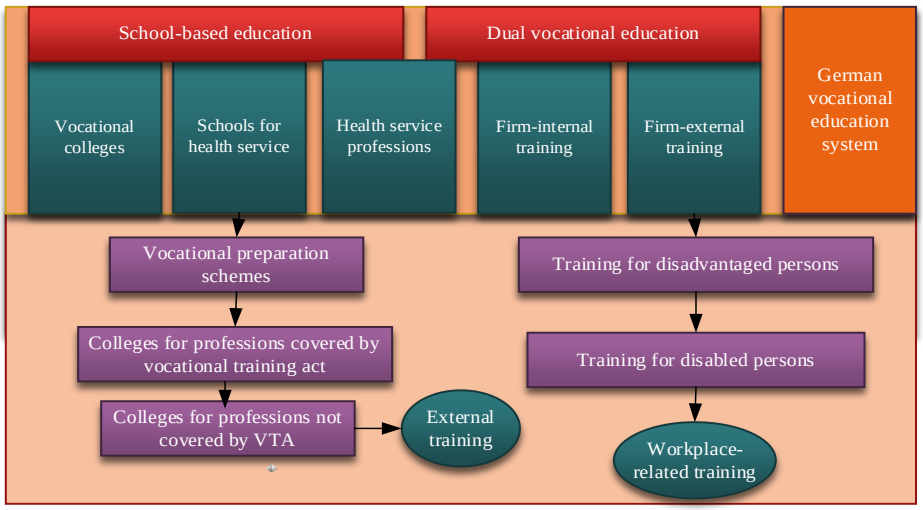

Figure 2. S-E cooperation systems

Role of vocational schools in training

Vocational schools which can be potentially changed into S-E enterprises play a major role in the success of the training model in a "dual system" (He Y, 2019). In the Chinese educational system, a vocational-technical school was usually a formal school independent of any enterprise, a sort of technical school affiliated to the local government and managed by the education department. These vocational and technical schools taught courses up to secondary levels. In recent years, due to the expansion of colleges and universities, more and more students prefer to go to ordinary, non-technical and non-vocational high schools to smoothen their admission in universities. As a result, vocational and technical schools find it challenging to recruit students and some are on the verge of bankruptcy (Mu H, 2020). Although these vocational and technical schools have adopted various methods to survive like merging two or three schools, and rebuilding and refurbishing their school buildings with modern and advanced equipment. Such attempts have not yielded any results. The schools are therefore trying to find the root cause of their failure to attract students to vocational schools. The real situation is not the need to develop infrastructure or construct new buildings. The problem lies in their failure to align with the social needs and providing need-based labor force. The curriculum of these vocational schools is also not aligned with the social needs. Students cannot master a practical skill even after three years of theoretical knowledge. Faced with such an embarrassing situation, it is therefore suggested that China should emulate Germany's "dual system" of vocational education.

There are several prerequisites to introduce the German "dual system" of vocational education. First of all, vocational-technical schools should coordinate with nearby companies to train students in school (Haisheng P, 2016). Students spend about 50 percent of the school time to learn cultural and professional knowledge—the other half can be devoted to the company to train students in industrial practical operational procedures. Since most students plan to work immediately after graduation, such practical training is more viable in vocational schools. In addition, students should not be required to pay any additional fee for such training. The state should rather formulate relevant policies and regulations according to which the enterprise will have to pay a certain stipend to the trainees during the training period. This will help develop students' enthusiasm for vocational education and solve specific financial problems of students. Though such training may not be sufficient to help students become independent and skilled workers, it can still make them develop some practical skills.

Secondly, vocational and technical schools should use nationally unified training materials, which must be practical and keeping pace with the time. The training modules and the equipment must be compatible with the enterprise's actual operation and have a certain degree of flexibility. The education department should modify textbooks and include such practical modules that would ensure that students are able to work independently in the same field after graduation (Z. B., 2019). Teachers in vocational and technical schools should organize a unified movement, and they should not exclude rural students.

The innovation based on the "dual system."

In the context of Chinese vocational education, the S-E cooperation model can prove to be a useful and most suitable training model; though the Chinese education system is much different from the German system because of many differences between the two countries. Hence, if a training model for the development of vocational education is to be established in China, it must be innovation based and will differ from the German "dual system" S-E cooperation. There will be several innovations in the Chinese version of "dual system," of S-E cooperation; for instance, the ratio of theoretical courses would need to be increased. The balance of theory to practice the dual system model in Germany is 1:3, while in China it would be 1:1 (Mu H, 2020). China is facing rapid technological development, innovation and economic growth; and so shall the companies involved in S-E cooperation model introduce technical updates in their training. Students need to possess a substantial and rich theoretical knowledge so that they are not eliminated due to rapid technological progress.

There are several other perspectives to be examined prior to introducing the "dual-system" in Chinese vocation education system. First, vocational schools in China do not rely on enterprises but are managed by local educational administrative agencies. Both schools and administrative agencies are in equal and cooperative relationship. Second, vocational schools' management shows a lot of economic flexibility in running the school, to avoid any financial burden on enterprises. Third, China has become world's largest processing factory because of its abundant and cheap labor resources (He Y, 2019), a state that will remain for a long time. Lastly, China is facing a great demand for labor with general skills. It is therefore not necessary to provide all vocational school students with high-quality training. Moreover, the material resources and talents are also limited and cannot meet training standards. In the Chinese, context, a short-term, practical, and quick-effective training model should be most suitable for the country's current needs. Some innovations can be brought into practice to suit the Chinese socio-economic situation.

Moreover, if the "dual-system" is to be introduced in China, the school will first need to contact the enterprise in a relevant industry prior to signing a training contract with a student. If the enterprise agrees, it will need to arrange training period according to the specific circumstances of each student. For example, many students from rural background need to undertake part-time family farming

business, besides studying in the school. The enterprise needs to consider this and adjust the time of training appropriately as per the student's time. If enterprises consider this limitation and choose the training time according to students' personal circumstances, it will help to prevent many students from dropping out of school. The schematic diagram of S-E cooperation institutions is shown in Figure 3.

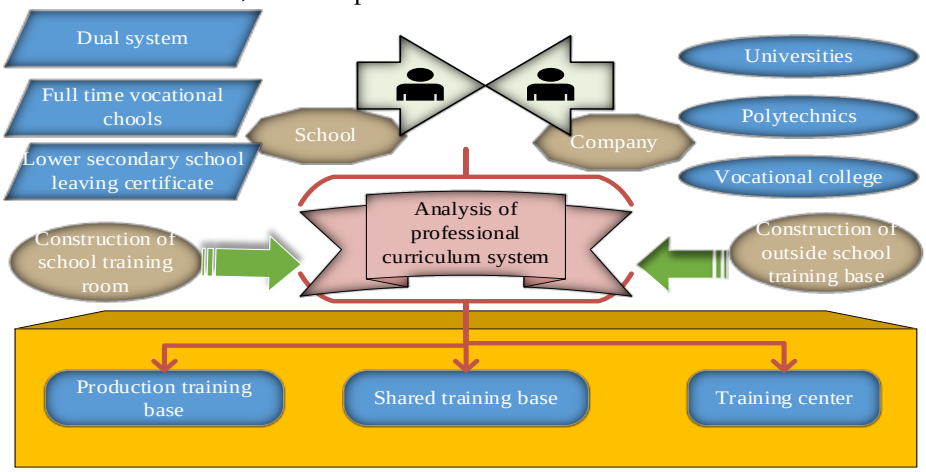

Figure 3. Schematic diagrams of S-E cooperation institutions

Evaluation model for the effectiveness of S-E cooperation in vocational education

There are several documents and studies on S-E cooperation in vocational education. There is also no dearth of research on the evaluation index system to judge S-E cooperation's effectiveness. However, there is a lack of systematic and comprehensive research on evaluation of the effectiveness of vocational education. Owing to evaluating the in-depth requirements and performance of S-E cooperation in vocational education and its effectiveness, it is objectively essential to shift attention from theoretical research and standard research to verification by empirical testing methods. This is bound to be a development trend and direction. Moreover, the government advocates and encourages S-E cooperation to promote social development. It is therefore essential to examine the correlation between social employment and social-economic development in the context of S-E cooperation. Last, but not the least, students' participation in S-E cooperation and determinants of their progress are also subjects of study, which are currently not included in this study (Yao., 2018).

Comprehensive evaluation of the effectiveness of vocational education S-E cooperation

In recent years, Chinese scholars have turned their attention to comprehensive evaluation of S-E cooperation in vocational education. A large amount of research has been published which helps in a thorough assessment of S-E collaboration and in-depth understanding and analysis of the current scenario. These research studies have helped in resolving many problems related to S-E cooperation in vocational education and fully mobilizing S-E cooperation parties to improve effectiveness of S-E cooperation. The research content has also shown a trend of continuous enrichment and in-depth analysis of the whole situation. The research methods have also been based on the trend of contemporary scientific diversification (Zhaohua W, 2019). Early research though had mainly focused on comprehensive evaluation of vocational education and talent training under S-E cooperation model. In the overall assessment of S-E collaboration, the movement of school personnel is also considered as the evaluation content. Yi-Ling L et al (2018), while evaluating S-E cooperation model, clubbed school variables such as curriculum reform, building teaching material, teacher team formation, practical teaching content and like with professional talent training plan, industry-university-interaction, and technical services. All these variables are primary evaluation indicators in the current research.

Procedures and steps for constructing fuzzy comprehensive evaluation of the effectiveness of S-E cooperation model in vocational education

According to the previously established evaluation index system for the effectiveness of S-E cooperation model, the comprehensive evaluation of S-E cooperation's energy can be understood from three aspects: participation, profitability, and development. In addition, there are secondary indicators that follow the basic ideas and principles of fuzzy comprehensive evaluation method, based on fuzzy mathematics. It is a process of comprehensively evaluating the membership level of any object derived from multiple indicators and based on the characteristics of ambiguous relationship between factors. Specifically, the first step is to determine the set of factors (indicators) of the evaluated object. Next, the evaluation (level) is set and each factor's weight and their vectors are determined to obtain the evaluation matrix. Finally, the fuzzy evaluation matrix

fuzzy calculation and normalization are performed with the weight vector of the factor weight.

All these aspects require different elements that help the evaluation system to coordinate and inspect the leading evaluation indicators. It is therefore advised that the evaluation system for the effectiveness of vocational education S-E cooperation should be based on basic level indicators. The other necessary secondary evaluation indicators should be later set up jointly to constitute the evaluation index system for the effectiveness of S-E cooperation, as shown in Figure 4. This figure determines the effectiveness of S-E cooperation model and its evaluation for the success of vocational education. This study will attempt to examine the most appropriate consultation method to scientifically determine each factor's weight and build a unique corresponding evaluation matrix. Conventionally, various indicators of vocational education S-E cooperation effectiveness evaluation system are first evaluated; then a comprehensive evaluation of the vocational education S-E cooperation effectiveness is conducted.

The general steps of a fuzzy comprehensive evaluation of the effectiveness of S-E cooperation in China are as follows: first, determine the set of factors that evaluate the strength of S-E collaboration in vocational education; second, choose the set of characteristics that assesses the effectiveness of S-E cooperation in vocational education; third, determine the location of vocational education S-E cooperation (Juan, 2019). The weight distribution of each evaluation factor of cooperation effectiveness determines the transformation matrix *R* of evaluation of the effectiveness of vocational education S-E cooperation. This establishes the first-level multi-factor model, and the second-level fuzzy model.

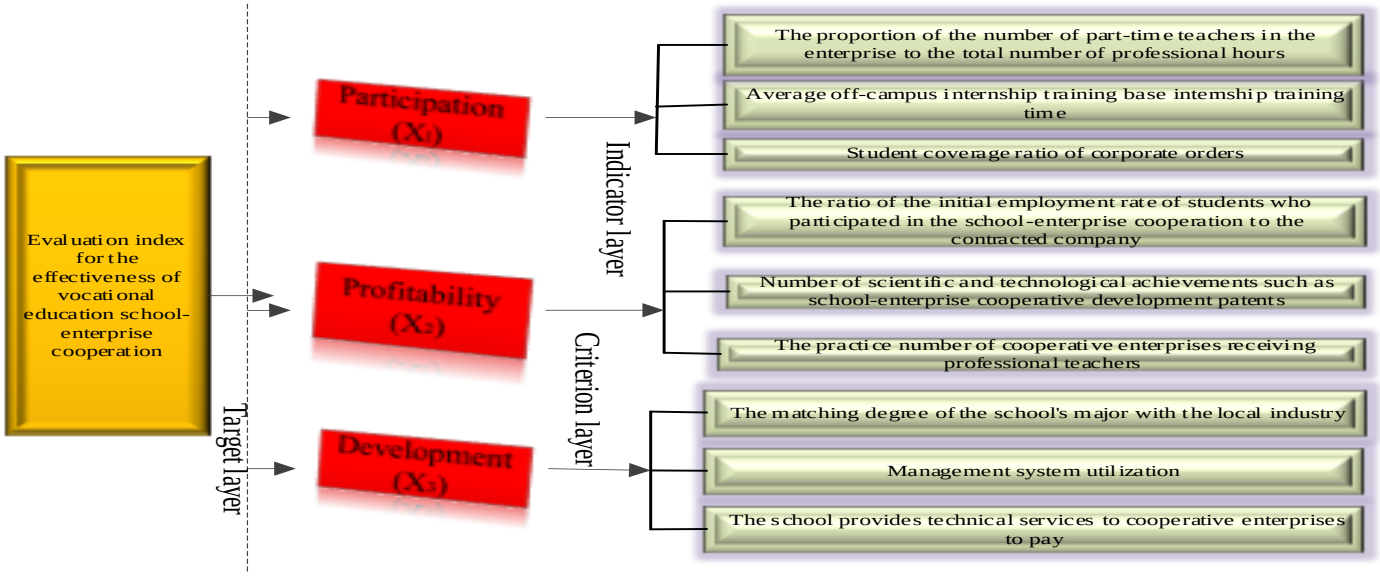

Figure 4. The effectiveness of S-E cooperation in my country's vocational education

The set of factors that determine the effectiveness of S-E cooperation evaluation

According to Figure 4, the effectiveness evaluation of S-E cooperation in China's vocational education (school version) can be set as $X = (x_1, x_2, ..., x_n)$ the factor affecting the evaluation object $i = 1, 2, ..., n$. In this study, $X = (x_1, x_2, x_3)$ that is, *X*= S-E cooperation participation degree X_1; vocational education S-E cooperation income degree X_2; vocational education S-E cooperation development degree X_3, where $X_1 = (a_{11}, a_{12}, a_{13})$ $X_2 = (a_{21}, a_{22}, a_{23})$, $X_3 = (a_{31}, a_{32}, a_{33})$.

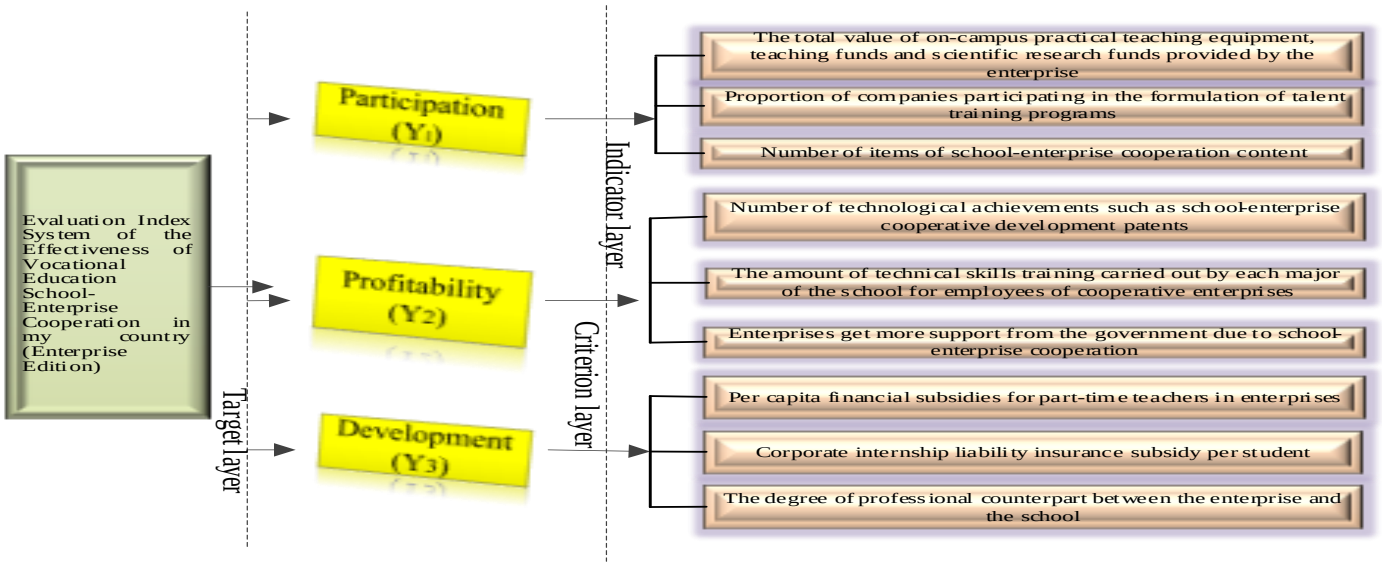

Figure 5. Evaluation index system of the effectiveness of S-E cooperation in my country's vocational education (Enterprise Edition)

According to Figure 5, the effectiveness evaluation of S-E cooperation in China's vocational education (enterprise version) can be set as $Y = (y_1, y_2, ..., y_n)$ the factor affecting the evaluation object $i = 1, 2, ..., n$. In this research $Y = (y_1, y_2, y_3)$, Y= S-E cooperation participation degree Y_1; vocational education S-E cooperation income degree Y_2; vocational education S-E cooperation development degree Y_3. Where $Y_1 = (b_{11}, b_{12}, b_{13})$ $Y_2 = (b_{21}, b_{22}, b_{23})$, $Y_3 = (b_{31}, b_{32}, b_{33})$.

Determining the weight set between the evaluation factors of the effectiveness of vocational education S-E cooperation

According to the index system for vocational education S-E cooperation listed in Tables 1 and 2, this study has used an expert evaluation method to determine the weight scientifically. This study designed an evaluation index system for the effectiveness of S-E cooperation in vocational education and selected 10 experts (5 business experts and 5 school experts) who had practical work experience in this field and profound theoretical accomplishments. This index system required to fill in the template to obtain the weights, sum up the weights assigned by 10 experts to each indicator, normalize the results, and determine each evaluation indicator's final consequences. To be suitable for fuzzy calculation, it was assumed that the sum of each evaluation index's weight components is 1. According to the research needs, the set of weight coefficients constituted by the first-level indicators are set up as: $P = (f_1, f_2, f_3)$ and $Q = (\delta_1, \delta_2, \delta_3)$. The weight of the first index is shown in Figure 6.

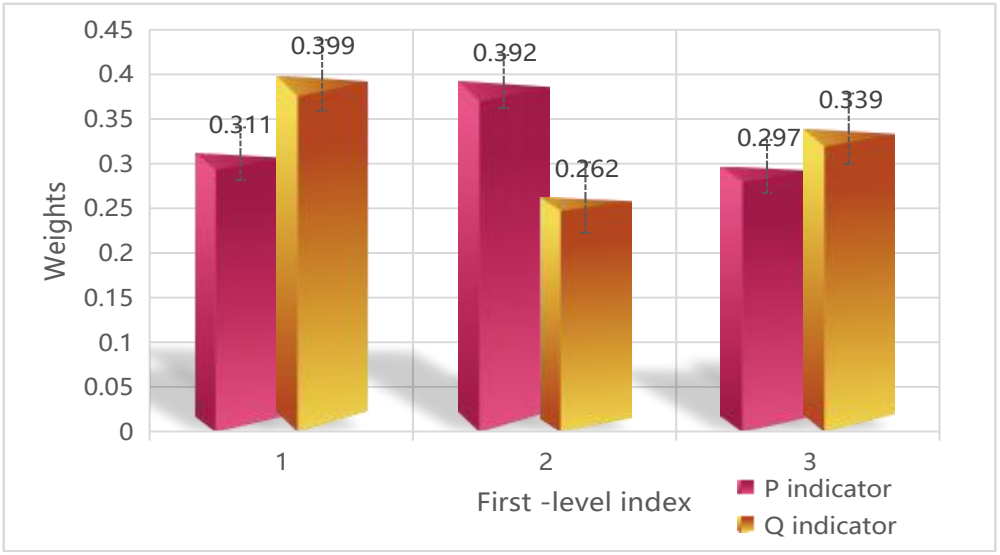

Figure 6. The weights of the first-level indicators

This study selected five (5) experts each with practical work experience in the field of vocational education and with profound theoretical accomplishments. Five managers were also engaged in S-E cooperation in enterprises to collect the evaluation data of various indicators of S-E cooperation effectiveness and to perform statistical processing. The weights of the secondary indicators are shown in Figure 7 and Figure 8.

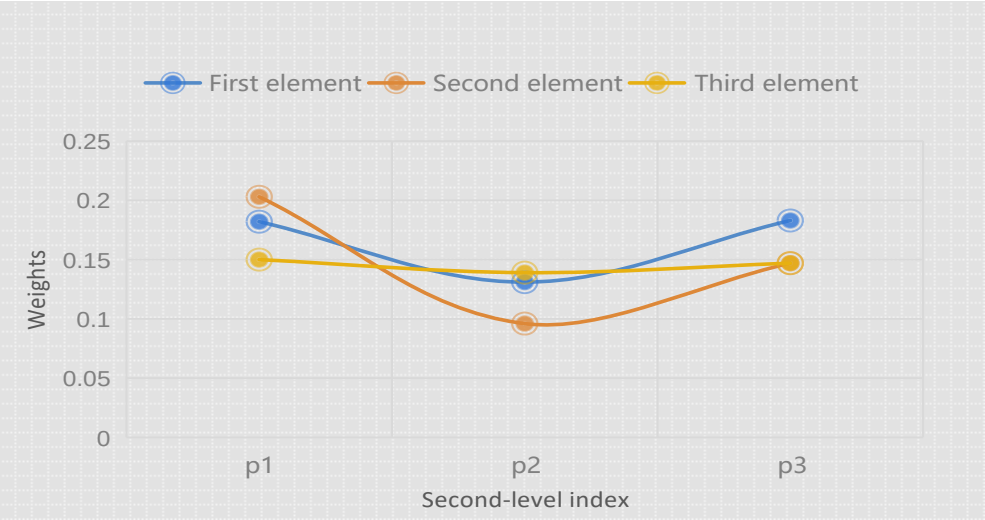

Figure 7. The weights of the second-level indicators

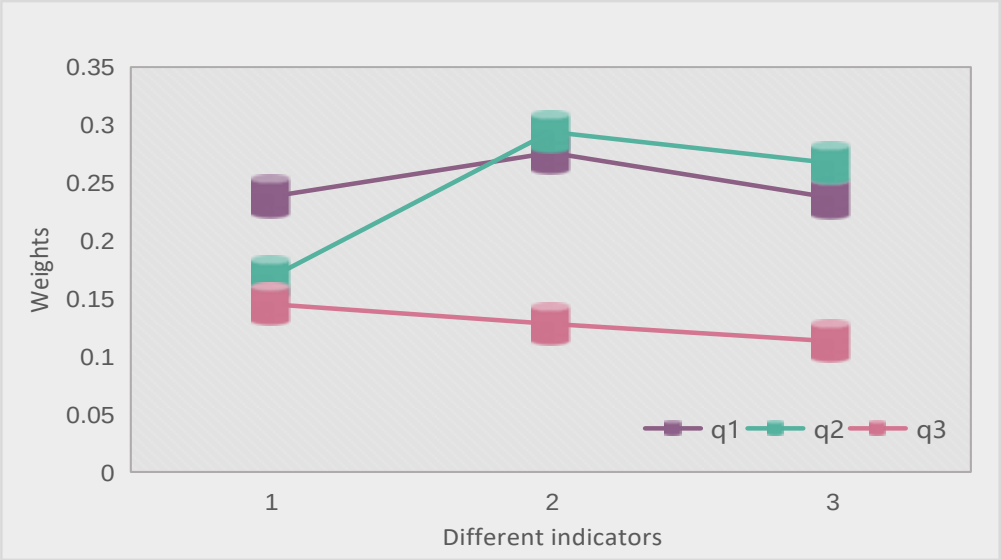

Figure 8. The weights of the second-level indicators

Determining the transformation matrix of fuzzy comprehensive of the effectiveness of S-E cooperation

For the *i-th* index, the membership degree of each comment is a fuzzy subset of *V* through making a judgment of each index. The comment level of each index is given so that the relationship between the evaluation indexes is determined. The comment level is also established, that is, the fuzzy relationship matrix from *U* to *V* is given. Thus, each index is presented as:

$$\varphi(i)=[\overrightarrow{\varphi_1}(i),\overrightarrow{\varphi_2}(i),...\overrightarrow{\varphi_m}(i)]=\begin{pmatrix} r_{11(i)} & r_{11(i)} & \cdots & r_{1m(i)} \\ r_{21(i)} & r_{21(i)} & \cdots & r_{2m(i)} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{n1(i)} & r_{n1(i)} & \cdots & r_{nm(i)} \end{pmatrix}$$

Among them, *"i"* represents the evaluation indicators, and *"m"* represents the subjects. *"n(i)"* means the evaluation indicators under the *i-th* primary evaluation indicator.

Establishing the evaluation model for the effectiveness of vocational education S-E cooperation

In order to establish the evaluation model for the effectiveness of vocational education S-E cooperation, a first-level multi-factor fuzzy comprehensive evaluation model is required. The single-factor fuzzy evaluation can only reflect one factor's influence on the object of evaluation. A thorough review is also required to obtain all factors' full effect on the evaluation object. $X=(x_1, x_2,..., x_n)$ And fuzzy evaluation transformation matrix R can construct the following single-level fuzzy comprehensive evaluation model:

$$Y = X \circ R = (x_1, x_2, x_3) \begin{pmatrix} r_{11(i)} & r_{11(i)} & \cdots & r_{1m(i)} \\ r_{21(i)} & r_{21(i)} & \cdots & r_{2m(i)} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{n1(i)} & r_{n1(i)} & \cdots & r_{nm(i)} \end{pmatrix}$$

In a complex system, there are many factors to be considered. There are often multiple levels among multiple factors. If there are sub-factor sets like *u*, there are still many more elements. The *u* can be further subdivided into multi-level models. This type of multi-level problem first requires a comprehensive evaluation of the sub-factors and a thorough overall assessment. The process involves a comprehensively integration of the lowest-level factors, incorporating the higher-level elements, and gradually incorporating them until the highest level is reached (Guan Zhimin, 2005; Gao Liqing, 2010). This study only needs to construct a secondary evaluation model; an evaluation model for evaluating the effectiveness of S-E cooperation, which in China has the following model:

$$Y = X \circ R = (x_1, x_2, x_3) \circ \begin{pmatrix} Y_1 \\ Y_2 \\ \cdots \\ Y_m \end{pmatrix}$$

It can be seen from the above formula that *X* is the weight of *I* factors u in the fuzzy comprehensive evaluation *(i=3)*. *R* is the fuzzy evaluation transformation matrix of the first layer and the second layer, respectively. Y is the total evaluation result of the effectiveness of the S-E cooperation in the Chinese education system. Figure 9 shows the effect of regression of the complete evaluation model at the point of S-E cooperation.

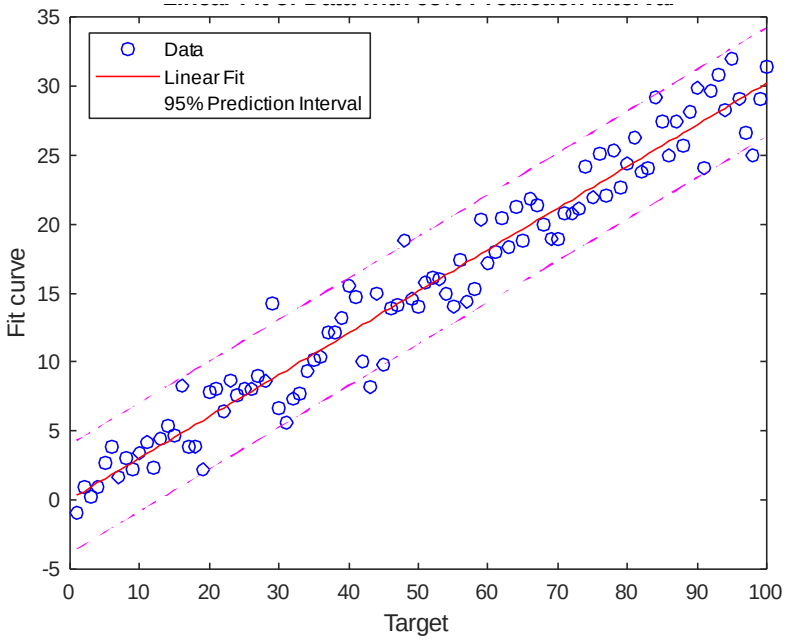

Figure 9. Regression of the comprehensive evaluation model of the effectiveness of vocational education S-E cooperation

Conclusion

This paper first followed the basic principles of conciseness, operability, integrity, orientation, and simplicity established by the index system. According to the current actual situation of S-E cooperation in China's vocational education, the vague comprehensive evaluation theory and expert analysis method were used to determine results. The complete evaluation system comprised school version and the enterprise version to examine the effectiveness of S-E cooperation. The study also included the point of S-E cooperation process, the usefulness of the results, and the effectiveness of development. Three first-level indicator dimensions and two three-level vocational education indicators have been established in this study. Based on a preliminary comprehensive evaluation's fundamental precept and ideas, a fuzzy comprehensive evaluation model for S-E cooperation's effectiveness for china was also constructed. The study concludes with a complete evaluation mechanism and evaluation process of the model.

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