The Feasibility of Practical Vocational Education in Higher Education Institutions

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Abstract—Practical vocational education needs to lay stress on the integration of theoretical knowledge of common courses such as PE and other cultural courses with the professional knowledge of various high vocational courses. However, existing studies on practical vocational education emphasize more on theoretical research, while the practical and empirical research is slightly insufficient. For this reason, this paper attempts to analyze the feasibility of practical vocational education in higher education institutions. At first, the paper analyzed the influencing factors of the effect of practical vocational education on vocational college students, and adopted Partial Least Squares (PLS) regression to explain the independent variable and 17 dependent variables of the said effect and the relationship between each evaluation index and the corresponding evaluation criterion. Then, to verify the feasibility of practical vocational education in regional higher education institutions, this paper employed an optimized Back Propagation Neural Network (BPNN) to predict the effect of practical vocational education on vocational college students. At last, the experimental results proved the effectiveness of the constructed model and gave the conclusion of feasibility analysis.

Keywords—higher education, practical vocational education, feasibility analysis, Partial Least Squares (PLS) regression, Back Propagation Neural Network (BPNN)

1 Introduction

A common problem with present vocational college students is the poor comprehensive quality (including both physical quality and cultural literacy), which makes them unable to adapt to their job positions and the working environment [1-4], and this indicates that the current effect of practical vocational education in higher education institutions has failed to show the professional features of vocational college students and meet their employment requirements [5-9]. In the process of higher vocational education, combining job position requirements with student quality improvement, exploring structure, content, and evaluation of relevant courses, and constructing a curriculum system that fits the features of vocational education, are especially important for enhancing students' awareness of comprehensive quality im-

provement and cultivating their adaptability to future job positions and working environment [10-13]. Practical vocational education needs to lay stress on the integration of theoretical knowledge of common courses such as PE and other cultural courses with the professional knowledge of various high vocational courses. Issues such as merging vocational skill training with labor skill training, teaching students in a simulated environment that is close to the actual working environment, and improving students' adaptability are all valuable research questions that need to be solved.

Akili [14] demonstrated the positive contribution made by part-time teachers to the class since they have brought practical experience into the classroom and create connections with the industry, which often provide opportunities for graduates such as opening job positions, carrying out collaborative activities, and participating in research programs. The positive outcome of such experience can encourage part-time teachers to work with full-time teachers, and seek the assistance of practitioners to introduce career practicality into the classroom. As economy is booming in China in recent years, the demand for talents grows fast, and the phenomenon of the incompatibility between student quality cultivated by higher education institutions and actual needs of the society becomes more significant. Xing [15] took the advantage of ant colony algorithm to process data, effectively evaluated the problems existing in the teaching of practical business English course in colleges and universities, and optimized the strategies of practical vocational education according to the evaluation results, thereby achieving the purpose of cultivating more qualified English talents for the society. Practical vocational education is a good way to consolidate theoretical knowledge and deepen understandings, and it is also an important means to train students to master scientific methods and improve their operational ability. Aiming at figuring out students' feelings about practical vocational education and assessing the teaching conditions of practical vocational education, Zhao and Xu [16] investigated the course setting of practical vocational education from perspectives of teaching methods, teaching modes, course comment, and improvement of vocational ability; besides, the investigation data were subject to factor analysis and regression analysis, and four factors of vocational adaptability, vocational action ability, teaching design of practical vocational education, and teaching assistance of practical vocational education were extracted from the improvement of vocational ability and the setting of practical vocational education. Zhao [17] studied the evaluation of the effectiveness of practical vocational education of ideological and political courses in higher vocational colleges in the context of micro-culture. Based on several index selection principles, an evaluation index system was constructed and a judgement matrix was built to determine the weights of the indexes, then the value assignment method was adopted to allocate the evaluation indexes, and the final scores were calculated to determine the evaluation levels and give the final conclusions of the effectiveness evaluation. In conventional methods, structural equations and density-based clustering methods are usually used to perform cluster analysis on the influencing factors of the effect of practical vocational education of PE lessens, however, Zhu [18] designed a decision tree model for the influencing factors of practical vocational education effect of PE lessens, and applied K-means clustering algorithm to classify the basic information data of college students' physical exercise; then, according to the results of data clus-

tering and combining with the basic ideas and concepts of decision tree, this paper adopted the ID3 algorithm to construct a decision tree model for the influencing factors of practical vocational education effect of PE lessens.

Existing studies on practical vocational education emphasize more on theoretical research, while the practical and empirical research is slightly insufficient, and few of them took the feasibility of practical vocational education in regional higher education institutions as the research object. Therefore, to fill in this research blank, targeting at letting the practical vocational education serve the regional real economy, this paper combined with the structural adjustment features of regional practical vocational education to study the feasibility of applying this mode in regional higher education institutions, in the hopes of providing reference for the curriculum reform of practical vocational education in higher education institutions. In the second chapter, this paper analyzed the influencing factors of the effect of practical vocational education on vocational college students, and adopted the PLS regression to explain the independent variable and 17 dependent variables of the said effect and the relationship between each evaluation index and the corresponding evaluation criterion. Then, to verify the feasibility of practical vocational education in regional higher education institutions, the third chapter employed an optimized BPNN to predict the effect of practical vocational education on vocational college students. At last, the experimental results proved the effectiveness of the constructed model and gave the conclusion of feasibility analysis.

2 About the influencing factors

For traditional higher education institutions, the cultivation effect of students' comprehensive quality could be measured by the improvement of various abilities of students, including the reading and writing ability, information acquisition ability, data analysis ability, collaboration ability, learning ability, logical thinking ability, independent thinking and problem-solving ability, social ability, and organization and management ability. After analyzing the training goals and course requirements of each major in higher education institutions and referring to domestic and foreign standards of vocational ability training, in this paper, the evaluation indexes of the practical vocational ability of vocational college students were summarized, except for the above mentioned nine aspects, other aspects such as professional ethics, career development concept, summarization and feedback ability, cultural literacy, aesthetic ability, basic sports skills, social sports ability, and health care ability should be included as well. All evaluation indexes have the corresponding evaluation criteria, the details won't be repeated here.

This paper adopted PLS regression to explain the independent variable and 17 dependent variables of the effect of practical vocational education on vocational college students and the relationship between each evaluation index and the corresponding evaluation criterion. This method doesn't require a large sample size, and it has good adaptability to the multicollinearity problem of small sample size. The model analysis was carried out based on Principal Component Analysis (PCA) and multiple regres-

sion method, which had effectively avoided the influence of multiple correlations on the constructed model.

Assuming: A represents the effect of practical vocational education on vocational college students, it is the independent variable; B represents evaluation criteria, namely the dependent variables; m represents the evaluation sample size; o represents the number of evaluation indexes in the independent variable; w represents the number of evaluation criteria in the dependent variables; then the matrix forms of A and B are:

$$A = \begin{pmatrix} a_{11} & a_{12} & \text{L} & a_{1o} \\ a_{21} & a_{22} & \text{L} & a_{2o} \\ \text{M} & \text{M} & \text{O} & \text{M} \\ a_{m1} & a_{m2} & \text{L} & a_{mo} \end{pmatrix} \tag{1}$$

$$B = \begin{pmatrix} b_{11} & b_{12} & \text{L} & b_{1w} \\ b_{21} & b_{22} & \text{L} & b_{2w} \\ \text{M} & \text{M} & \text{O} & \text{M} \\ b_{m1} & b_{m2} & \text{L} & b_{mw} \end{pmatrix} \tag{2}$$

A and B were standardized to get matrices D_0 and G_0:

$$D_0 = \begin{pmatrix} a_{11}^* & a_{12}^* & \text{L} & a_{1o}^* \\ a_{21}^* & a_{22}^* & \text{L} & a_{2o}^* \\ \text{M} & \text{M} & \text{O} & \text{M} \\ a_{m1}^* & a_{m2}^* & \text{L} & a_{mo}^* \end{pmatrix} \tag{3}$$

$$G_0 = \begin{pmatrix} b_{11}^* & b_{12}^* & \text{L} & b_{1w}^* \\ b_{21}^* & b_{22}^* & \text{L} & b_{2w}^* \\ \text{M} & \text{M} & \text{O} & \text{M} \\ b_{m1}^* & b_{m2}^* & \text{L} & b_{mw}^* \end{pmatrix} \tag{4}$$

wherein, $a_{ij}^*=a_{ij}-a_j^-/r_{aj}$, $i=2,...,m$, $j=1,2,...,o$; r_{aj} represents the standard deviation of a_j; similarly, $b_{ij}^*=b_{ij}-b_j^-/r_{bj}$, $i=2,...m$, $j=1,2,...,w$; r_{bj} represents the standard deviation of b_j. Assuming: q_1 represents the first axis vector of D_0; z_1 represents the first axis vector of G_0, then, based on Formulas 5 and 6, the principal components ψ_1 and v_1 were extracted:

$$\psi = q_{11}a_1^* + \text{L} + q_{1o}a_o^* = D_0 q_1 \tag{5}$$

$$v_1 = z_{11}b_1^* + \text{L} + z_{1o}b_o^* = G_0 z_1 \tag{6}$$

Formula 7 gives the solution constraints:

$$\begin{cases} Cov(\psi_1, v_1) = \sqrt{Var(\psi_1)Var(v_1)}s(\psi_1, v_1) \to max \\ \max\limits_{q_1, z_1} < D_0 q_1, G_0 z_1 > s.t q_1^T q_1 = 1, z_1^T z_1 = 1 \end{cases} \tag{7}$$

This paper used PLS regression to analyze the samples of the practical vocational education effect of vocational college students, calculation process of the constructed model is given in detail below:

- Step 1: Collect the data of the independent variables and dependent variables, and use trend extrapolation to reasonably supplement the missing data;
- Step 2: Standardize the collected data samples to reduce the influence of dimensions on the prediction results, thereby effectively reducing the prediction errors;
- Step 3: Use PCA to eliminate the multicollinearity between evaluation indexes;
- Step 4: Perform regression on the extracted principal components of evaluation indexes and their dependent variables, use the least square method to determine the parameters of the regression equation between principal components and dependent variables, and further restore the regression equation between evaluation indexes and dependent variables before extracting the principal components;
- Step 5: Use the constructed regression equation to explain the relationship between the effect of practical vocational education on vocational college students and the 17 dependent variables of each evaluation index and the corresponding evaluation criteria, and attain the conclusion.

3 Feasibility prediction of practical vocational education

In order to verify the feasibility of practical vocational education in regional higher education institutions, this paper adopted an optimized BPNN to predict the effect of practical vocational education on vocational college students. In the proposed BPNN, assuming: $[a_1,a_2,...,a_j]$ represents the input of a set of evaluation index sample data; C_j represents the final output attained after the basic calculations of two layers of the neural network; $[q_{1j},q_{2j},...,q_{ij}]$ represents the weight vector of the j-th neuron between the input layer and the hidden layer; φ_j represents the bias between the input layer and the hidden layer; when the sample information is transmitted from the input layer to the hidden layer, the receiving vector B_j could be attained by superimposing the bias of hidden layer neurons with the weighted input:

$$V_j = \sum_{i=1}^{m} q_{ij} u_i + \phi_j \tag{8}$$

$$C_j = g\left(B_j\right) \tag{9}$$

Assuming: 7-m-1 represents the structure of the neural network; $[a_1,a_2,...,a_7]$ represents the input layer; q_1 represents the weight matrix from the input layer to the hidden layer; q_2 represents the weight matrix from the hidden layer to the output layer; Y_1

represents the bias vector of the hidden layer; Y_2 represents the bias vector of the output layer, then the output C_1 from the input layer to the hidden layer could be attained based on B_1:

$$B_1 = Q_1^T A + Y_1 \tag{10}$$

The output C_2 from the hidden layer to the output layer could be attained based on C_1:

$$B_2 = Q_2^T C_1 + Y_2 = Q_2^T \left(g\left(Q_1^T A + Y_1 \right) \right) + Y_2 \tag{11}$$

$$C_2 = g_2\left(B_2 \right) = g_2\left(Q_2^T \left(g_1\left(Q_1^T A + Y_1 \right) \right) + Y_2 \right) \tag{12}$$

The idea of using Genetic Algorithm (GA) to optimize BPNN is mainly to optimize the initial weights and thresholds of the network. Figure 1 gives the flow of GA. In this paper, GA was used to continuously optimize the weights and thresholds of the network during the model execution process, and a prediction model for forecasting the effect of practical vocational education on vocational college students was established based on GA and BPNN.

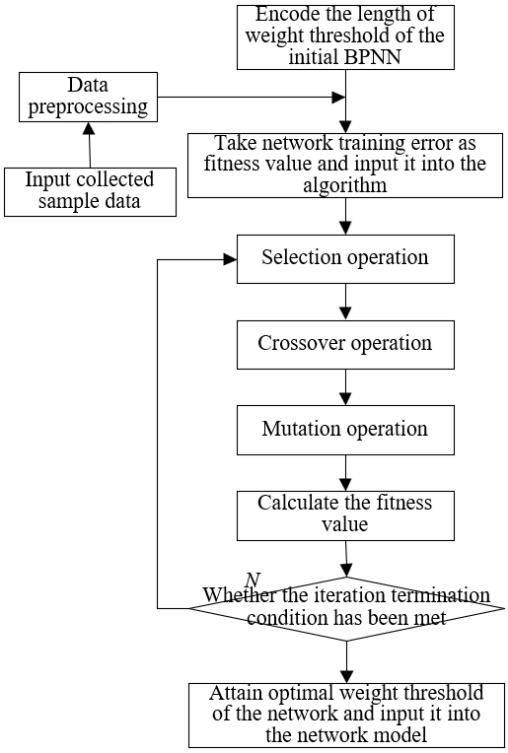

Fig. 1. Flow of genetic algorithm

- Step 1: Determine the topology of the model, and determine the initial weights, thresholds, and the number of neuron nodes in each layer of the network.
- Step 2: Normalize the original evaluation data such as the students' reading and writing ability and information acquisition ability, etc., and input the normalized data into the constructed network model.
- Step 3: Determine the parameters of GA, initialize the chromosome population, encode each chromosome individual into a real number string which consists four parts of q_1, Y_1, q_2 and Y_2.
- Step 4: Let b_i represent expected output and b'_i represent predicted output value, then calculate the fitness degree of chromosome individuals in the population:

$$G = 1 / \sum_{i=1}^{M} abs\left(b_i^{'} - b_i\right) \tag{13}$$

- Step 5: Perform selection, crossover, and mutation operations on chromosome individuals, retain chromosome individuals with high fitness, and eliminate those with low fitness. Let M represent the number of chromosome individuals in the population and λ represent the fitness of the i-th chromosome individual, then Formula 14 gives the expression of the selection operation of chromosome individuals:

$$\lambda_i = G_i / \sum_{i=1}^{M} G_i \tag{14}$$

Since the encoding method of chromosome individuals was real number string encoding, the crossover operations were performed based on real number crossover method. Assuming: η represents random number between [0, 1], then Formula 15 gives the expression of the crossover operation between the l-th chromosome x_l and the first chromosome x_1:

$$\begin{aligned} x_{lj} &= x_{lj}\left(1-\eta\right) + x_{1j}\eta \\ x_{1j} &= x_{1j}\left(1-\eta\right) + x_{lj}\eta \end{aligned} \tag{15}$$

Assuming: x_{max} and x_{min} represent the upper and lower bounds of the gene; s_2 represents a random number; h represents the current iteration number; H_{max} represents the maximum evolution number; s represents random number in [0,1], then the expression of mutation operation is:

$$x_{ij} = \begin{cases} x_{ij} + \left(x_{ij} - x_{max}\right) \times g\left(h\right), s > 0.5 \\ x_{ij} + \left(x_{min} - x_{ij}\right) \times g\left(h\right), s \le 0.5 \end{cases} \tag{16}$$

$$g\left(h\right) = s_2 \times \left(1 - h / H_{max}\right)^2 \tag{17}$$

- Step 6: Calculate the fitness values of chromosome individuals; if a certain chromosome individual in the new population can make the network reach the global

optimal, or the number of iterations reaches the preset maximum value, then execute Step 7, otherwise return to Step 5.

- Step 7: Output the chromosome individual with the highest fitness, and get the corresponding weights and thresholds when the network reaches global optimal.
- Step 8: Input the weights and thresholds attained in Step 7 into the network model, train the model based on the training samples until the error is less than the preset error threshold, and construct the prediction model for forecasting the effect of practical vocational education on vocational college students.
- Step 9: Input the test samples into the trained prediction model, and de-normalize the output results of the network to get the predicted value of the said effect. Figure 2 shows the flow of the optimized neural network.

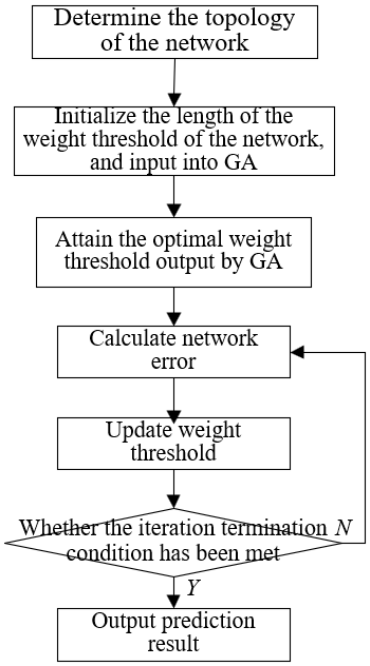

Fig. 2. Flow of the optimized neural network

4 Experimental results and discussion

To figure out the recognition and attitude of students and teachers in vocational colleges to practical vocational education, this study conducted a survey and counted the survey data. Table 1 gives the statistics of the survey results. According to the data shown in the table, 56.8% of the surveyed students were not clear about the concept of practical vocational education, 7.4% of the them never heard of it, and 58.9% of them knew it for the first via the questionnaire of this survey. Judging based on these results, the regional higher education institutions should make more efforts to pro-

mote practical vocational education. More than half of the surveyed students expressed interests in the beneficial effect of practical vocational education, which proves that they are willing to improve their comprehensive quality, and this finding is quite optimistic for higher education institutions to carry out practical vocational education reform in the schools.

Table 1. Recognition and attitude of students and teachers in vocational colleges to practical vocational education

Survey item 1		**Number of respondents**	**Proportion (%)**
Degree of understanding	Clear	42	3.3
	Not that clear	435	32.5
	Not clear at all	748	56.8
	Never heard of it	96	7.4
Total		1321	100%
Survey item 2		**Number of respondents**	**Proportion (%)**
Channel of knowing	Course	236	18.2
	Classmate	31	2.3
	Network	78	5.9
	Magazine	96	6.5
	Employment presentation	66	4.2
	Questionnaire	758	58.9
	Others	46	4
Total		1311	100%
Survey item 3		**Number of respondents**	**Proportion (%)**
Level of interest	Very interested	362	28
	Interested	758	50.1
	Average	142	12.7
	Not very interested	45	3.4
	Not interested at all	2	5.8
Total		1309	100%

Among the surveyed higher education institutions, more than 20% of them had set courses related to practical vocational education; 84.9% of surveyed teachers think it's necessary to organize unified trainings or teaching seminars related to practical vocational education; and 87.1% of them believe that the reform of practical vocational education is very necessary.

To verify the prediction effect of the optimized BPNN, this paper plotted the curve of average fitness degree, as shown in Figure 3, in the initial stage of iteration, the average fitness value of the algorithm decreased rapidly, after 9 iterations, the decrease showed down, then, between the 28th and the 31st iterations, the decrease sped up again, and after 31 iterations, the change trend tended to be stable, at this time, the optimal individual in the chromosome population had been chosen already, namely the optimized weights and thresholds of the BPNN.

Table 2. Recognition and attitude of teachers to practical vocational education

Survey item 1		**Number of respondents**	**Proportion (%)**
Degree of recognition	Very necessary	69	56.4
	Necessary	35	28.5
	Average	14	12.7
	Not necessary	5	1.8
	Not necessary at all	1	3
Total		128	114
Survey item 2		**Number of respondents**	**Proportion (%)**
Attitude towards execution	Very necessary	57	51.3
	Necessary	42	35.8
	Average	16	13.6
	Not necessary	5	2.8
	Not necessary at all	2	4
Total		121	112

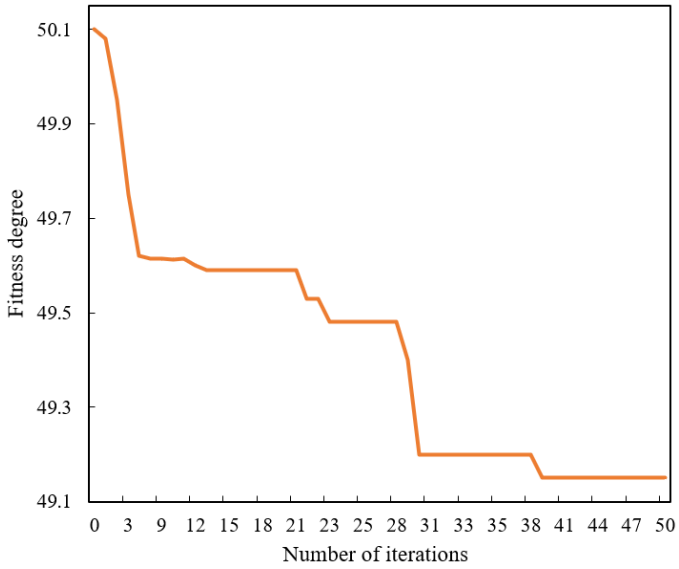

Fig. 3. Curve of average fitness degree

Figure 4 shows the prediction performance of the optimized neural network. The excellent fitting effect of the model could be verified by the scatter plot, which also proved the effectiveness of constructed neural network in predicting the effect of practical vocational education on vocational college students, moreover, combining with the experiment, it can also verify the feasibility of promoting practical vocational education in higher education institutions.

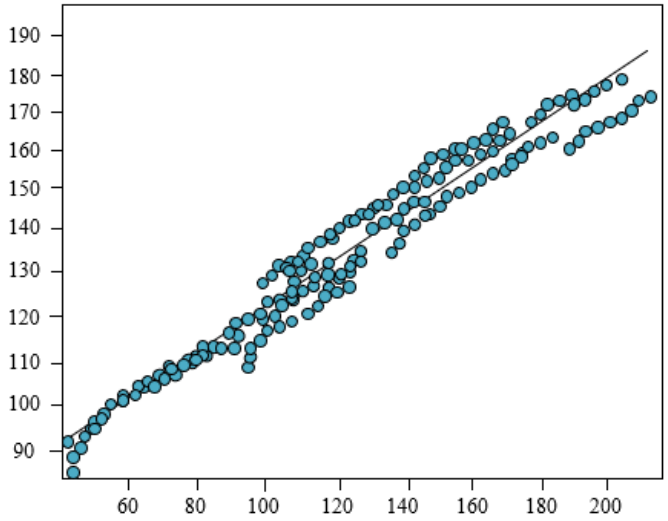

Fig. 4. Prediction performance of the optimized BPNN

To further improve the feasibility of the implementation strategies of practical vocational education, this paper took PE major as an example to perform comparative experiment on teachers' design process of the teaching scheme for practical vocational education. Figures 5, 6 and 7 give PE teachers' preferences for teaching content when giving practical vocational education of different types of jobs. People who engage in long sitting jobs are prone to health problems such as pains in waists, neck, shoulders, or obesity; people who engage in long standing jobs are prone to diseases such as varicose vein of lower limbs and strain of lumbar muscles; labor-intensive jobs put higher requirements for the physical function of college students, and people engage in this type of job are prone to healthy problems with waist and lower limbs.

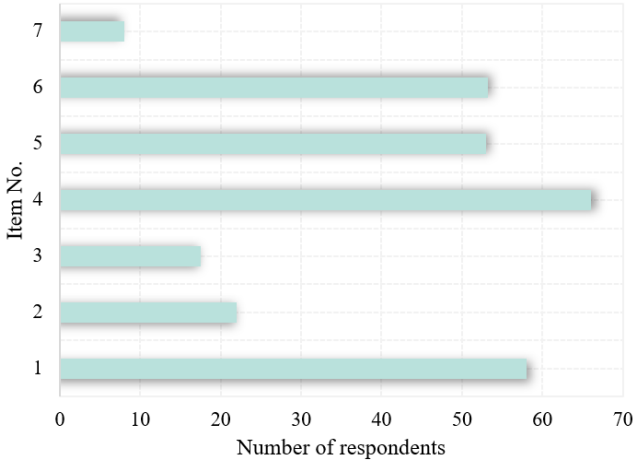

Fig. 5. Statistics of practical vocational education for long sitting jobs

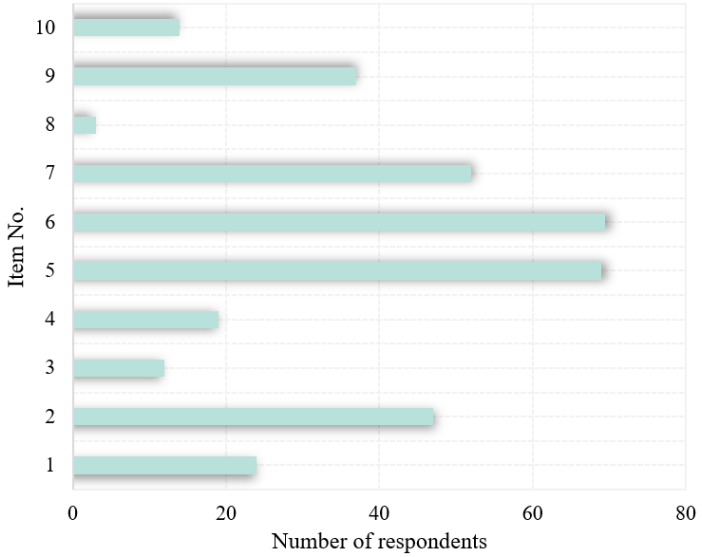

Fig. 6. Statistics of practical vocational education for long standing jobs

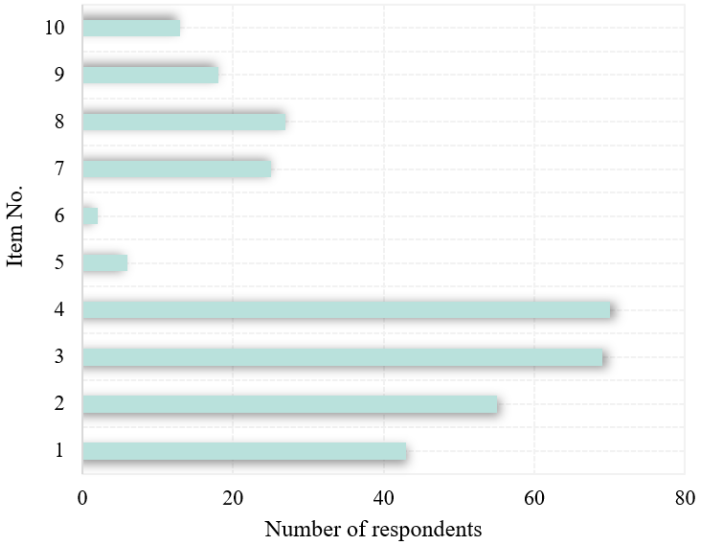

Fig. 7. Statistics of practical vocational education for labor-intensive jobs

For the teaching content of practical vocational education for long sitting jobs, PE teachers generally choose 7 types of training programs, including aerobics (1), dancesport (2), table tennis (3), swimming (4), basketball (5), Tai Chi (6), and football (7). More PE teachers choose body dance as the training programs for this type of job. For the teaching content of practical vocational education for long standing jobs, PE teachers generally choose 10 types of training programs, including aerobics (1), danc-

esport (2), table tennis (3), swimming (4), basketball (5), Tai Chi (6), football (7), endurance running (8), rope skipping (9), and badminton (10). More PE teachers choose basketball and tai chi as the training programs for this type of job. In schools with better conditions, yoga course could be set for female students who will engage in long standing jobs in the future.

For the teaching content of practical vocational education for labor-intensive jobs, PE teachers generally choose 10 types of training programs, including aerobics (1), table tennis (2), basketball (3), rock climbing (4), dumbbells (5), single & parallel bars (6), football (7), endurance running (8), rope skipping (9), and badminton (10). These programs are more effective in improving the comprehensive physical quality of vocational college students, but more PE teachers choose basketball and rock climbing as the training programs for this type of job.

5 Conclusion

This paper analyzed the feasibility of carrying out practical vocational education in higher education institutions. At first, the influencing factors of the effect of practical vocational education on vocational college students were analyzed, and PLS regression was adopted to explain the independent variable and 17 dependent variables of the said effect and the relationship between each evaluation index and the corresponding evaluation criterion. Then, to verify the feasibility of carrying out practical vocational education in higher education institutions, an optimized BPNN was employed to predict the effect of practical vocational education on vocational college students.

Moreover, this study conducted a survey to figure out the recognition and attitude of students and teachers in vocational colleges to the practical vocational education, verified the prediction effect of the constructed BPNN in forecasting the effect of practical vocational education on vocational college students, and proved the feasibility of promoting practical vocational education in vocational colleges via experiment. To further improve the feasibility of the implementation strategies of practical vocational education, this paper took PE major as an example to perform comparative experiment on teachers' design process of the teaching scheme for practical vocational education, and gave the experimental results.

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