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Influence factors and research on higher vocational students' reluctance to advance to higher education based on random forest and structural equation modelling

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Abstract. This study aims to explore the key factors influencing Chinese higher vocational students' reluctance to pursue higher education. By combining two analytical methods, Random Forest and Structural Equation Modeling, the study targeted students enrolled in Guangdong Finance and Trade Vocational College, designed a questionnaire containing various aspects such as study habits, self-perception, and internship experience, and collected 107 samples for analysis. The study found that students' personal intention to pursue higher education was the most critical factor influencing whether they chose to continue their studies, followed by the evaluation of their own learning ability and economic considerations. In addition, family cultural resources and learning environment also influence students' attitudes towards further education to a certain extent. The study also reveals the effects of the positive interaction between personal factors and family cultural resources support, and the negative interaction between personal factors and economic factors on the intention to pursue higher education. Based on these findings, the article presents recommendations for the school, family, and social levels to promote higher education students' willingness to pursue higher education and educational equity.

Keywords: higher vocational education, willingness to advance to higher education, random forests, structural equation modelling

1. Introduction

As an important branch of higher education, higher vocational education focuses on the cultivation of high-quality skilled personnel who can adapt to the needs of front-line work in the fields of production, construction, service and management [1]. It emphasizes vocational pertinence and vocational skill cultivation, and has the characteristics of vocational, popular, industrial and social [2]. Higher vocational education is people-oriented, takes employment as a guide, and is committed to improving students' vocational ability and promoting employment. Currently China's higher vocational education plays a pivotal role in the national economy. With the continuous upgrading of China's industrial structure and the emergence of new business models, higher vocational education is like a powerful engine that drives the continuous growth of the economy. By continuously improving the quality of human capital, higher vocational education promotes the improvement of total factor productivity [3] and provides solid support for China's economy to realize the transformation and upgrading from high-speed growth to high-quality development.

According to the information released by the Ministry of Education of the People's Republic of China, in 2023, the total number of higher education institutions in China was 3,074, of which 1,545 were higher vocational (specialized) colleges and universities [4], accounting for about 50.27%, and occupying almost half of the country. China's vocational education system is in the world's leading position in terms of scale and development, and every year millions of children from families graduate from vocational education colleges and universities, but there is still a gap between the current level of vocational education and the needs of social and economic development. In the context of the era of gradual massification and even popularization of higher education in China, a strong craze for further studies is emerging in the field of vocational education. Taking the data on the number of applicants and admissions of the Guangdong Provincial Education Examination Institute, for example, the number of applicants has realized a surge in just four years: the number of applicants was 90,900 in 2020, and climbed to 169,700 in 2023, with a growth rate of more than 80%; at the same time, the number of admissions has also increased year by year, growing from 50,500 in 2020 to 95,400 in 2023 million people [5]. This trend not only reflects the strong demand for highly educated talents in the society, but also reflects the desire and pursuit of vocational education students themselves to improve their qualifications and expand their career

development space. However, not all vocational education students will choose to go to college, and this choice is affected by many factors. For those students who do not want to go to college, their decision may be constrained by family economic conditions, personal career planning, learning interests and other aspects. Studying the influencing factors of this group of students' choices can help to understand the needs and dilemmas of vocational education students more comprehensively and provide a strong basis for the formulation of educational policies and the deepening of educational reform.

This study adopts two analytical methods, random forest and structural equation modeling, to comprehensively and deeply explore the key factors influencing the reluctance of higher vocational students to pursue higher education. Random forest, as an integrated learning algorithm with strong interpretability, is able to deal with variables with high feature dimensions and assess the importance of each variable in the prediction results, so as to identify the factors that significantly influence students' reluctance to go on to higher education. Structural equation modeling, on the other hand, is able to further reveal the intrinsic relationships and paths of action between these factors, providing a more in-depth understanding. Focusing on and studying the group of students who do not want to go on to higher education not only helps to better understand the educational needs and developmental dilemmas of higher vocational students, but also provides an important scientific basis for the reform of vocational education and the guidance of student development. At the same time, it is of great practical significance for improving the education system and promoting educational equity and social harmony.

2. Literature review

Chinese higher education schools should be benchmarked against foreign community colleges, so the literature for foreign countries partially uses studies related to community college transfers to four-year colleges. Jabbar and Edwards found that community college students may be reluctant to transfer because of a lack of confidence in their academic abilities. This lack of confidence may stem from the difficulty of community college courses, fear of the unknown at a four-year university, and concerns about academic challenges [6]. Castro and Cortez highlighted the impact of cultural and social adjustment issues on transfer students through qualitative research. Especially for minority and first-generation college students, adapting to the cultural and social environment of a new school can become a significant challenge [7]. Backes and Velez noted that information asymmetry and misinformation can lead to confusion for community college students during the transfer process. Lack of accurate information about the transfer process, degree requirements, and transfer agreements may make students hesitant [8]. Scott-Clayton's study revealed that tuition, cost of living, and financial aid availability were key factors for students when considering transfer. Financial pressure may force some students to give up the opportunity to transfer [9]. Gong Lei found through a questionnaire survey that higher vocational students generally feel that mathematics, foreign language and professional theory courses are difficult, and these courses are also the parts that they feel that their mastery is insufficient during internships, which suggests that the difficulty of the courses and the internship experience may be an important factor affecting students' willingness to go on to higher education [10]. Hui Yuan Yuan pointed out that factors such as the low student population of higher vocational colleges and universities, the ambiguity of students' career goals, the unclear positioning of talent cultivation goals, the certain pressure on the development of higher vocational education, and the excessive number of post-secondary education programs resulting in a waste of teaching resources may affect students' willingness to go on to higher education [11]. Tai Hushan indicated that higher vocational students are not satisfied with the enrollment scale of post-secondary education, and there are many dissatisfactions with the current policy of post-secondary education, such as the restriction of majors, examination subjects, and admission methods. These policy factors are also key factors affecting students' willingness to pursue higher education [12]. Pan Yingjie mentioned that the higher vocational post-secondary student group generally have goals and plans, but they are not strong in action, and they are easily affected by recreational activities and give up their plans. This reflects that students' self-management ability and mobility is another important factor affecting their willingness to pursue higher education [13].

The above literature has explored the various factors of higher education students' unwillingness to pursue higher education from different perspectives, but there are still some shortcomings. First, most studies focus on a single level of analysis, such as academic ability, economic pressure or policy influence, and lack a comprehensive examination of the interaction between students' individual factors and the external environment. Second, most of the existing studies use qualitative methods or quantitative analysis based on small samples, which is difficult to generalize to a wider group of higher education students. Finally, most of the existing literature focuses on the group of students who are willing to pursue higher education, while relatively little attention is paid to the group of students who choose not to pursue higher education. This research tendency may have led to a simplified understanding of the complexity behind higher education students' decision to pursue higher education, ignoring the voices of reluctant students and the dilemmas they face. Behind these choices lie a variety of deep-rooted social, psychological, and educational factors that deserve to be explored in depth. In addition, the College Entrance Examination (CEE) has been developed in China for more than 20 years, forming a large group of higher vocational to undergraduate learners. However, despite the significant scale, the research on this group is still insufficient in the education academy, with few relevant papers, and the existing studies are mostly superficial, lacking in-depth theoretical and modeling discussions. At the same time, it should be noted that there are currently relatively few quantitative studies on related research, which are not based on in-depth analysis by establishing interpretability models [14]. In recent years, artificial intelligence algorithms have permeated various fields, including medical care [15], computer vision [16], car driving [17], object detection [18-19], education [20]. etc. Artificial intelligence algorithm has become one of the mainstreams of quantitative research, especially the decision-making tree algorithm, including boosting class algorithm，xgboost [21] and lightgbt [22], and random forest algorithm [23].

Based on the shortcomings of the above literature and the gaps in the research field of higher vocational students going to undergraduate school, this study takes the students of Guangdong Finance and Trade Vocational College as the research object, and utilizes the two analytical methods of Random Forest and Structural Equation Modeling comprehensively, aiming to comprehensively and deeply explore the key factors of the unwillingness of higher vocational students to go on to undergraduate school, as well as the inherent relationship between the two factors. By designing a questionnaire covering various aspects such as study habits, self-perception, and internship experience, this study not only focuses on the influencing factors at the individual level, but also reveals the interactions and pathways between these factors. This comprehensive research method is expected to fill the gaps of existing studies and provide a more scientific and comprehensive basis for the policy making of higher vocational education and the guidance of student development, which is of great theoretical and practical significance. At the same time, this study also expands the traditional research perspectives and digs into the root causes of higher vocational students' reluctance to pursue higher education at a deeper level, and by focusing on this relatively neglected group, it is expected to trigger more discussions and reflections on educational fairness, diversified development, and social inclusiveness.

3. Methodology

In this study, the feature screening was carried out by combining the Python programming language and the random forest algorithm in the Scikit-learn library, and the factor analysis and path analysis were carried out by using SEM of SPSS and python. Taking the students of Guangdong Finance and Trade Vocational College as the research object, 107 samples were finally collected through questionnaires (70 questions in total), and before the analysis was carried out, the dataset was firstly subjected to the preprocessing work, which included the steps of dealing with the missing values and standardizing the features. Then the categorical data were converted into numerical data, and a total of 69 features were obtained after binary coding and uni-hot coding conversion, and the features included students' personal information, family background, and attitudes. The target variable is whether the student has the intention to go to higher education.

Random forest is an integrated learning method that improves the predictive performance of the overall model by constructing multiple decision trees and aggregating their predictions. The main advantages of random forests are that they can handle high-dimensional data, avoid overfitting, possess high robustness, and can accurately assess the importance of features [24]. The key metrics of random forest include feature importance, accuracy, recall and F1 score. Random forests can quantify the contribution of features to the classification performance of a model by comparing the difference between the probability distribution predicted by the model and the true label probability distribution. In this study, Cross-Entropy Loss (CEL) is chosen as a metric to assess the importance of features, and features with higher CEL contribute more to the model's prediction accuracy and can be considered more important. The specific calculation formula is as follows:

For a binary classification problem：

$$L(y,p) = -[y\log(p) + (1-y)\log(1-p)] \tag{1}$$

where y is the true label (0 or 1), and p is the probability predicted by the model for the positive class.

For multi-class problems：

$$L = -\sum_{i=1}^{C} y_i \log(p_i) \tag{2}$$

where y is a one-hot encoded vector representing the true label, and p is the vector of predicted probabilities for each class, with C being the total number of classes.

Based on the principle of the above algorithmic formulation, the model was constructed using the RandomForestClassifier from the Scikit-learn library. In the process of model construction, key parameters such as the number of trees, maximum depth, etc. were selected. Meanwhile, the dataset was randomly divided into two disjoint subsets according to the ratio of about 80% training set and 20% test set by using the hold-out method (hold-out method): 74 samples and 69 features for training set features, and 33 samples and 69 features for test set features, which were used for model fitting and evaluation. After the training is completed, the built-in mechanism of the Random Forest classifier is utilized to calculate the cross-entropy loss gain by accessing the feature_importances_attribute of the model, so as to accurately assess the relative importance of each feature in the prediction process, and the model yields an accuracy of about 93.94% on the test set, and obtains a cross-entropy loss value of about 0.26, which indicates that the Random Forest model performs well on this dataset with high accuracy and relatively low cross-entropy loss. Finally, the importance scores of each feature are obtained, and the importance scores of the top ten influences on higher vocational students' willingness to pursue higher education are as follows.

Table 1. Feature importance rank

Serial number	Questionnaire Title	Importance Score
1	42. Do you have the intention to continue your studies	0.244588

Serial number	Questionnaire Title	Importance Score
2	43. Do you think your current learning ability is sufficient for higher level study?	0.056040
3	70. Regarding the impact of financial burden on the willingness to pursue higher education	0.046976
4	45. Do you believe that pursuing higher education will enhance your career opportunities?	0.043857
5	7. Which of the following ranges does your family's book collection fall into?	0.027537
6	35. Do you enjoy going to bookstores or libraries?	0.023613
7	8. Do you have a separate study space (e.g., separate room or desk) in your home?	0.021291
8	4. What is your physical health condition?	0.020258
9	11. Do your parents often talk to you about your studies and life?	0.019434
10	27. How clear is your future career plan?	0.019419

Comprehensively analyzing the results of the importance of random forest characteristics, the following conclusion can be drawn: among the many factors affecting whether students choose to continue their studies, the individual students' willingness to pursue higher education is the most crucial determinant, especially for those students who have explicitly expressed their unwillingness to continue their studies, and their individual willingness plays a dominant role. This factor is not as important as the willingness to pursue higher education, but should not be ignored, because students' confidence in their ability to cope with higher levels of study will, to a certain extent, affect their choice of higher education. Consideration of the economic dimension is also an important influencing factor, as many students may choose not to pursue further studies because they are unwilling or unable to bear the additional financial burden brought about by further studies. In addition, students' perceptions of whether pursuing further studies would bring career development opportunities would also affect their decision-making, and those who were unsure of their career development prospects after pursuing further studies were more likely to choose not to pursue further studies. Family cultural resources and learning environment, such as the number of books in the family collection and the communication between parents and their children, although relatively less influential, also influence students' attitudes towards further education in a subtle way. And those factors with relatively low importance of characteristics, such as whether students like to go to bookstores or libraries, and whether students have independent study space at home, have limited influence in students' decision-making on further education, but they are still factors that should not be completely ignored.

In order to further explore the potential relationships between these characteristics and their paths of influence on the target variables, factor and path analyses were conducted using SEM and python that utilize SPSS software. Structural equation modeling is a statistical technique used to analyze the relationship between variables, which consists of two main parts, the measurement model and the structural model, and is able to consider both direct and indirect effects between multiple variables. In this study, five latent variables and ten observed variables were selected based on the importance results of random forest.

Table 2. Design of latent and measured variables

Latent variable	Measured variables	Symbol
Dependent variable: personal willingness to go to higher education (Y)	Do you intend to continue your studies (e.g., to a bachelor's degree)?	Q42
Independent variable: personal factors (X1) Independent variable: career development (X2)	Do you think your current learning ability is sufficient for higher level (undergraduate) studies?	Q43, Q35
	Do you like to go to bookstores or libraries?	
Independent variable: family cultural resources and support (X3) Dependent variable: health status (X4)	How clear is your future career plan?	Q27, Q45
	Do you think pursuing higher education will enhance your career opportunities?	

Latent variable	Measured variables	Symbol
Independent variable: economic factors (X5) Dependent variable: personal willingness to go to higher education (Y) Independent variable: personal factors (X1)	Where does your family's book collection fall? Do you have a separate study space in your home (e.g., separate room or desk)? Do your parents often talk to you about your studies and life?	Q7, Q8, Q11
Independent variable: career development (X2)	What is your health condition?	Q4
Independent variable: family cultural resources and support (X3)	Influence of financial burden on willingness to go to university	Q70

Based on the conclusion of Random Forest to conclude the importance of characteristics, the following hypotheses are established, and the hypothesized model is shown in Figure 1.

H1: Personal factors have a direct effect on individual's willingness to pursue higher education.

H2: Career development has a direct effect on individuals' willingness to go to higher education.

H3: Family cultural resources and support have a direct effect on individuals' willingness to pursue higher education.

H4: Health condition has a direct influence on individuals' willingness to go to higher education.

H5: Economic factors have a direct influence on individuals' willingness to pursue higher education.

H6: Career development may mediate through personal factors to influence individuals' willingness to pursue higher education.

H7: Family cultural resources and support may mediate the effect of personal and economic factors on individuals' intention to pursue higher education.

H8: Economic factors may moderate the influence of personal factors and career development on individuals' intention to pursue higher education.

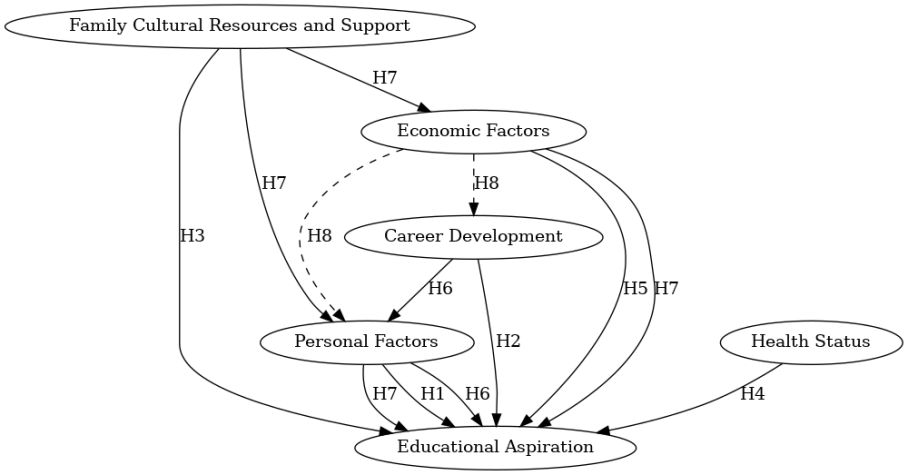

Figure 1. Structural equation modeling assumptions

4. Result

Exploratory factor analysis (EFA) and validation factor analysis (CFA) were conducted to verify the reliability and validity of the measurement model prior to SEM analysis. The Cronbach's Alpha of 0.670, KMO value of 0.750, Bartlett's test of sphericity chi-square value of 374.210, and significance level of 0 were analyzed by SPSS software, which proved that the questionnaire validity was satisfied, and the reliability was high enough to be analyzed for model testing. The model fitting was carried out using python's semopy package, and the results were extracted and presented via the inspect(model) method, and finally the estimates, standard errors, z-values and p-values of each path were obtained. The analytical model of the factors influencing the willingness of higher vocational colleges to go on to higher education was constructed, as shown in Figure 2.

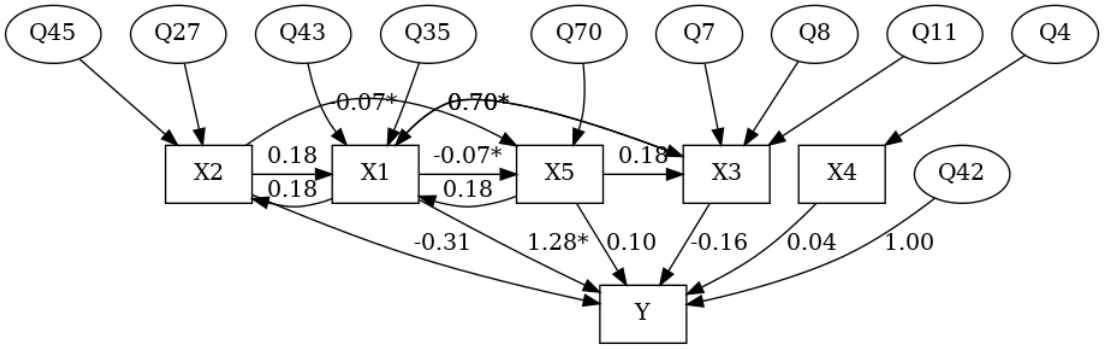

Figure 2. Structural equation modeling path diagram

The constructed structural equation model was solved by parameter estimation and fitting, as shown in Table 3, the chi-square degrees of freedom ratio of the model is $\chi 2/df<3$, GFI>0.9,IFI>0.9,RMR>0.05.The high RMR value is because the data are not standardized and processed the model contains both numerical and categorical variables, but the other key indexes are good, and collectively, the model passes the test .

Table 3. Fitting parameters of the model

norm	χ^2/df	GFI	IFI	RMR
value	1.817	0.926	0.987	0.105

The conclusions drawn from the constructed SEM are:

(1) Individual's willingness to pursue higher education (Y) is a complex decision-making outcome that is jointly influenced by multiple factors, and the results of the coefficients of the influence of separate independent variables on Y and the corresponding p-values are shown in Table 4, which suggests that the direct influence of personal factors (X1), career development (X2), family cultural resources and support (X3), health (X4), and economic factors (X5) on the willingness to pursue higher education is insignificant when they act individually.

Table 4. Coefficients and corresponding p-values of X1~X5 on Y

Variables	Impact Coefficient	p-values
Personal factors (X1)	1.281	0.288
Career development (X2)	-0.308	0.718
Family cultural resources and support (X3)	-0.159	0.807
Health status (X4)	0.037	0.955
Economic factors (X5)	0.101	0.855

(1) The interaction between family cultural resources and support (X3) and personal factors (X1) significantly and positively affects the willingness to pursue higher education, with the coefficient of X3 on X1 being 0.704 and the p-value being 0.0051. This suggests that cultural resources and support provided by the family enhances the personal factors of the higher education students, which, in turn, significantly increases their willingness to pursue higher education.

Specifically, a student who already has strong learning ability and interest in learning will be more confident and motivated to pursue higher qualifications when his or her family provides good cultural resources and support.

(3) The interaction between personal factors (X1) and economic factors (X5) has a significant negative effect on the individual's willingness to pursue higher education (Y), with an impact coefficient of -0.070 and a p-value of 0.041. This reveals that economic considerations are often one of the most important factors influencing the decision-making of higher vocational students to pursue higher education, and that even if an individual is ready to pursue higher education in terms of his/her learning ability and interest, if he/she also faces greater economic pressure or are more sensitive to financial burdens, then such economic considerations may weaken their original willingness to pursue higher education based on personal factors.

According to the research findings, this paper puts forward several suggestions for higher vocational students' willingness to go on to higher education based on different influencing factors, as shown in Table 5.

(1) Schools should provide more educational resources and support, especially for students with strong learning ability and interest in learning, to help them overcome the financial difficulties they may face in order to continue their studies. For example, financial assistance programs such as scholarships and bursaries should be set up to alleviate the financial burden of students who are willing to pursue further studies but have poor financial conditions. Schools should also strengthen their services on career planning and guidance for further studies to help students better understand the pathways to further studies and their future career development so that they can make informed decisions. Schools should provide psychological counseling services to help students relieve the pressure of further studies and deal with anxiety and confusion arising from financial factors.

(2) Families should actively provide cultural resources and support to encourage their children to pursue higher qualifications. Parents can provide a good learning environment and learning resources, as well as positive guidance and support when their children face the choice of further studies. For children who are willing to pursue higher education but are limited by financial conditions, families should try their best to provide financial support or find external financial assistance to alleviate their children's financial pressure. At the same time, parents should maintain good communication with their children, understand their aspirations for further education and career planning, and give understanding and support.

(3) The government and society should work together to improve the vocational education system and provide students with more opportunities for further education and diversified education paths. At the same time, it is necessary to formulate and implement financial assistance policies for higher vocational students to alleviate their financial pressure and further promote educational equity. In addition, it is crucial to improve social awareness and acceptance of higher vocational students' further education, to eliminate prejudice and discrimination against vocational education, and to create a fairer environment for higher vocational students to pursue higher education. Finally, in order to enhance students' confidence in career development, enterprises should also be encouraged to provide more internship and employment opportunities for higher vocational students.

Table 5. Summary of recommendations at three levels

Level	Recommendations
School	Educational Resources and Support
	Career planning and college guidance
	Psychological Counseling
Family	Cultural Resources and Support
	Economic Support
	Communication and understanding
Society	Improvement of education system
	Economic Assistance Policy
	Social Awareness and Acceptance
	Job Market Support

5. Conclusion

This study combines two analytical methods of modelling, Random Forest and Structural Equation Modelling, and starts from a multidimensional conduct containing study habits, self-perceptions, and internship experiences, and collects 107 samples for analysis in order to reveal the multifaceted reasons why higher education students are reluctant to continue their studies. The results of the study emphasize the significant influence of personal intentions on students' decision to pursue higher education, underpinned by students' assessment of their own learning abilities and financial constraints. At the same time, the study suggests that the interaction of personal and family factors enhances students' motivation to progress academically, while financial factors tend to discourage students from pursuing further studies. This suggests a complex interplay between intrinsic aspirations and extrinsic pressures in influencing educational outcomes. Based on these insights, this study recommends that educational institutes, families and policy makers work together to create a conducive environment for vocational students to progress to higher education. This includes strengthening financial support mechanisms, providing strong career guidance, and fostering a favorable family education environment, thereby achieving equity in higher education.

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