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Research on Strategies to Improve Digital Literacy of College Students to Enhance Employment Quality in the Intelligent Era

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Abstract

With the intensification of social employment pressure, the employment conflict of vocational college students has gradually shifted from quantitative to qualitative. The theoretical mechanism and path of the impact of digital literacy on the employment quality of vocational college students are explored through the combination of human capital and labor market theories in this study. In this paper, the digital literacy is used as an independent variable based on the employment quality as the dependent variable. The relevant control variable is set up, and the multivariate regression model is constructed. Finally, a questionnaire survey was conducted on college graduates in Jiangxi, and the influence and mechanism of digital literacy on the employment quality of college graduates were explored through a multiple regression analysis model. The results show that the regression coefficients of digital literacy of vocational college students are always positive, after all the control variables are included in the regression, the regression test coefficient of digital literacy level in the model (6) are, $R^2=5.15$, $P<0.001$.

Keywords: Vocational college students; Digital literacy; Employment quality; Multiple regression analysis.**AMS 2010 codes:** 93C62

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1 Introduction

Employment is China's first major livelihood project, the People's Heart project and foundation project, which is crucial to the realization of economic and social development and harmony and stability [1-2]. In the final stage of building a moderately prosperous society in all aspects, the employment issue is the most concerned, direct, and realistic interest of the people, which is related to the overall situation of reform, development, and stability [3-4]. The two sessions held in 2022 will take the employment issue as the main discussion issue, pointing out that it is necessary to put the promotion of employment in a more prominent position, to promote industrial transformation and upgrading, to promote the optimization and upgrading of industrial structure, and to expand the domestic demand [5-6]. With the booming development of the digital economy and the popularization of digital technology, the emerging economic forms have brought more jobs and employment opportunities [7-8]. In this regard, in recent years, China has put forward proposals to develop the digital economy to stabilize and expand employment, pointing out that the development of the digital economy should be used to realize the increase of jobs and ensure that the employment fundamentals can be expanded and the quality of employment can be improved in the process of economic transformation and upgrading [9]. Employment quality determines the well-being of workers, which is an important goal of economic and social development. Not only need to pay attention to the employment rate, but we also pay attention to the quality of people's employment [10]. In the context of the deep integration of information technology and production and life represented by the Internet, information literacy has become the necessary literacy of the labor force in the information age [11].

Doerr, A. used training as a means to improve women's digital literacy and analyzed the impact on employment after women had improved their digital literacy by selecting a control group for comparative analysis of German administrative empirical data. The results showed that the quality of employment of trained women was effectively improved, and the income gap with the pre-interruption period was reduced by 77% [12]. Zikic, J. et al. argued that the improvement of the technological literacy of citizens does not necessarily lead to an improvement in the quality of employment. Among those who choose skilled migration, the fact that conditions abroad do not meet their employment needs can be a certain hindrance. Through quantitative analysis of 356 Canadian skilled immigrants, it was found that the migration behavior caused by technological literacy enhancement and the transition to the new labor market would lead to dissatisfaction with the quality of employment [13]. Xue, K. et al. collected 194 samples of data from Sichuan Province, and six dimensions, such as the employment environment, were established as the evaluation indexes of the quality of employment, which were combined with the OLS path analysis model, and the analysis of the impact of the enhancement of digital literacy on the influence of digital literacy enhancement on employment quality. The results of the empirical investigation show that the use of the network positively affects the quality of employment, and in this regard, it is proposed to optimize the social network of farmers to ensure a high-quality employment environment for farmers [14]. Verhaest, D. et al. proposed that higher education needs to be measured early through the career and modeled the data by comparing the longitudinal data of the Belgian graduates by comparing the longitudinal data of Belgian graduates and filtering out the data of the bad matches. The results showed that there was no data to support this argument, elevating the argumentative discussion going forward [15]. Carmelo García-Pérez et al. proposed a methodology to analyze employment precariousness by means of parametric analysis through the Alkire-Foster double-threshold calculation. The empirical results show that Spain has a high incidence of multidimensional precarious employment, at 40%, and a high intensity. At the same time, this employment instability factor is aggravated over time and is accompanied by greater heterogeneity [16]. Pan, J. et al. investigated the impact of internship quality on the employment success of higher education students by means of an empirical examination based on the Job Characteristics Model and Career Constructs Theory. After four rounds of survey research

with 207 vocational college students, the data showed that internship quality showed a significant positive correlation with subsequent employment [17]. Brummund, P. et al. combined the policy context of the local area of the empirical study to propose a system of criteria for a multidimensional measure of employment quality, which considers the nature of work in this area in relation to the context of the area. It was found that the quality of work is caused by a combination of factors such as age and gender and that well-being and satisfaction are two important dimensions in examining the quality of work since 2003 [18]. Dust, S. B. et al. first proposed a negative correlation between the employment gap and fitness for work after a period of time and verified the proposed hypothesis by collecting multiboards of data from 157 workers. After a 10-year follow-up, the employment gap factors of these students were measured by the Mayer-Salovey-Caruso Emotional Intelligence Test, and emotional intelligence was found to be a contributing factor to the gap in the quality of employment [19]. Visser et al. looked at the bifurcation in the quality of employment and the implications for employment and economic development in the United States. The empirical investigation shows that these changes are manifested together in time and space. At the same time, Visser et al. proposed an innovative approach to calculating the quality of employment, during which the salient features of the employment structure are manifested in the increasing patterns of inequality in the labor market [20].

This paper characterizes digital literacy and hypothesizes about its influence on the employment quality of vocational college students. In terms of variable measurement, digital literacy is assessed in terms of digital awareness, digital competence, and digital ethics, and the employment quality of vocational college students is measured in terms of four dimensions, namely, job income, labor contract, job natural environment, and humanistic environment respectively. The impact and mechanism of digital literacy on vocational college students' employment quality are tested using structural equation modeling and multiple regression analysis based on 406 survey data from Jiangxi. Combined with the results of the study, strategies for enhancing digital literacy and improving the employment quality of vocational college students are proposed from three different subjects, which are digital consciousness, digital ability and digital ethics.

2 Research design on digital literacy and employment quality in the age of intelligence

2.1 Measurement of research variables

This section introduces the dependent variable, employment quality, the independent variables, digital literacy, the moderating variables social network, social norms, and the measures of human capital stock and human capital structure, and provides a brief description of the control variables. On this basis, the research model for this paper is constructed.

2.1.1 The Quality of Employment

The dependent variable in this paper is the quality of employment (Q), and there are currently three main types of indicators for measuring employment quality: single, composite, and multidimensional indicators. Wage or employment satisfaction are the only indicators of employment quality. Comprehensive indicators mainly refer to the division of employment quality into different first-level indicators, such as employment environment, employment capacity, employment security, remuneration, and labor relations etc. Under each first-level indicator, several second-level indicators are divided, and their weights are determined using either the weight method or expert scoring method and finally integrated into an index.

In combination with the principle of index construction, the secondary index of the construction of employment quality evaluation in this article contains the work income, the labor contract, the natural environment and the cultural environment [27], represented by $Q_1 \sim Q_4$ in turn.

2.1.2 Digital literacy

According to the discussion of the meaning and elements of the logarithms mentioned above, the digital literacy (DL) of higher vocational students is divided into digital consciousness, digital ability, and digital morality. Refer to the existing index system. The complete index design is shown in Table 1. Digital consciousness includes numerical sensitivity, effective adaptation number, digital value recognition, and digital association. Digital ability includes digital learning, digital business, digital decision-making, and digital social abilities. Digital ethics includes digital compliance, security, fair use, and digital sharing. [28].

Table 1. Complete index design of digital literacy

	Primary indicator	Secondary indicator	Symbol
Digital literacy	Digital consciousness (Y)	Numerical sensitivity	Y_1
		Number active adaptation	Y_2
		Digital value recognition	Y_3
		Digital Association	Y_4
	Digital capability (L)	Digital learning ability	L_1
		Digital business ability	L_2
		Digital decision-making ability	L_3
		Digital social ability	L_4
	Digital moral (V)	Digital law-abiding	V_1
		Digital security	V_2
		Digital fair use	V_3
		Digital sharing	V_4

2.1.3 Social capital

The moderating variable in this paper is social capital, which is categorized into structural and cognitive social capital. The two dimensions of social network (SCN) and social norms (SCR) are selected by the classification as measures of regional social capital [29-30]. The specific refinement indicators are shown in Table 2. According to the refined indicators, the entropy value method is used to determine the weight and entropy value of each indicator, which is then used to calculate the composite score of the first-level indicators that correspond to the refined indicators.

Table 2. Index system of social capital measurement in different dimensions

Primary index	Secondary index	Indexes and measurement method	Index code	Direction
Social network	Information network	The general phone number with the area ratio of the population	T2	+
	Economic network	The commodity market turnover of one hundred million yuan of above	T3	+
	Interpersonal network	Accommodation and catering industry value among regions	T4	+
Social norms	Legal norms	Number of traffic accidents accounted for the proportion of motor vehicle drivers	T5	-
	Group norms	The proportion of the number of private non-enterprise units in the population of each region	T6	+

In this paper, we use the software Matlab 2020a to obtain the combined score of social network and social norm indicators. Here is the exact formula:

1) Indicator standardization processing:

Positive indicators:

$$X_{ij} = \frac{X_{ij} - \min(X_{1j}, X_{2j}, \dots, X_{nj})}{\max(X_{1j}, X_{2j}, \dots, X_{nj}) - \min(X_{1j}, X_{2j}, \dots, X_{nj})} + 1, \begin{matrix} i = 1, 2, \dots, n \\ j = 1, 2, \dots, m \end{matrix} \quad (1)$$

Negative indicators:

$$X_{ij} = \frac{\max(X_{1j}, X_{2j}, \dots, X_{nj}) - X_{ij}}{\max(X_{1j}, X_{2j}, \dots, X_{nj}) - \min(X_{1j}, X_{2j}, \dots, X_{nj})} + 1, \begin{matrix} i = 1, 2, \dots, n \\ j = 1, 2, \dots, m \end{matrix} \quad (2)$$

2) Calculate the weight of the indicator:

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^n X_{ij}}, j = 1, 2, \dots, m \quad (3)$$

3) Calculate the weights of the indicators:

$$W_j = \frac{g_j}{\sum_{j=1}^m g_i}, j = 1, 2, \dots, m \quad (4)$$

4) Calculate the composite score:

$$S_i = \sum_{j=1}^m W_j * P_{ij}, i = 1, 2, \dots, n \quad (5)$$

2.1.4 Human capital

Moderating human capital variability. Two dimensions of human capital stock (HC) and human capital structure (HU) are chosen in this paper to measure regional human capital [31-32].

The process of human capital accumulation is influenced by educational experiences, and the knowledge people acquire through education aids them in adapting to new environments and technologies. The average years of education are chosen to measure the stock of regional human capital.

The index of advanced human capital structure is chosen to measure the human capital structure of each region in this paper.

2.2 Research Modeling

This paper focuses on the impact of vocational college students' digital literacy on their employment quality in the age of intelligence, and the two-way fixed-effects model serves as the baseline model for the study, with a total of six econometric models constructed for hypothesis testing. The construction of the model is based on the following:

$$Q_{it} = \alpha_0 + \alpha_1 Control_{it} + \mu_{it} + \varepsilon_{it} \quad (6)$$

$$Q_{it} = \alpha_0 + \alpha_1 Control_{it} + \alpha_2 DL + \mu_{it} + \varepsilon_{it} \quad (7)$$

An econometric model was constructed to test the hypothesized moderating role of social capital between the level of digital literacy and employment quality of vocational college students:

$$Q_{it} = \alpha_0 + \alpha_1 Control_{it} + \alpha_2 DL + \alpha_3 SCN_{it} + \alpha_4 FA * SCN_{it} + \mu_{it} + \varepsilon_{it} \quad (8)$$

$$Q_{it} = \alpha_0 + \alpha_1 Control_{it} + \alpha_2 DL + \alpha_3 SCR_{it} + \alpha_4 FA * SCR_{it} + \mu_{it} + \varepsilon_{it} \quad (9)$$

An econometric model was constructed to test the hypothesized moderating role of human capital between the level of digital literacy and the quality of employment among vocational college students:

$$Q_{it} = \alpha_0 + \alpha_1 Control_{it} + \alpha_2 DL + \alpha_3 HC_{it} + \alpha_4 DL * HC_{it} + \mu_{it} + \varepsilon_{it} \quad (10)$$

$$Q_{it} = \alpha_0 + \alpha_1 Control_{it} + \alpha_2 DL + \alpha_3 HU_{it} + \alpha_4 DL * HU_{it} + \mu_{it} + \varepsilon_{it} \quad (11)$$

Where ui is the unobserved individual effect, ε_{it} represents the random disturbance term, and DL_{it} is the core explanatory variable of this paper, i.e. the level of digital literacy. SCN_{it} represents the social network in each region, SCR_{it} represents the social norms in each region, HC_{it} represents the human capital stock in each region, and HU_{it} represents the index of advanced human capital structure in each region.

3 Study on the impact of digital literacy and quality of employment of vocational college students

3.1 Data sources and descriptive statistics

3.1.1 Data sources

To examine the effects and mechanisms of digital literacy on the employment quality of vocational college students, this study devises a questionnaire and gathers data based on the previous hypothesized model. The questionnaire takes each observable variable as a survey question item and adopts a five-point Likert scale for scoring, which is rated and filled in by the vocational college students themselves, e.g., a score of 5 means digital sensitivity is “very strong,” and a score of 1 means “very weak,” and the other observable variables are measured in the same way as this one. The same method was used to measure other observable variables. From September 2023 to January 2024, the research group conducted questionnaire surveys and in-depth interviews with vocational college graduates in Jiangxi using simple random sampling.

The survey respondents were vocational college students within 5 years of graduation with a bachelor’s degree or above and involved a total of 12 industries, including traditional industries such as manufacturing, construction, and express delivery, as well as digital new industries such as online education, Internet medical care, and live streaming with goods. Each city issued 150 questionnaires, totaling 450. 421 were recovered, of which 406 were valid questionnaires, with a recovery rate of 93.56% and a validity rate of 90.22%, respectively.

3.1.2 Descriptive statistics of variables

SPSS 22.0 is employed to organize and analyze the data collected in this paper. Table 3 shows descriptive statistics on the selection of specific variables and their self-ratings regarding employment quality, digital awareness, digital ability, and digital ethics among vocational college students. It can be seen that the mean scores of work income (Q_1), labor contract (Q_2), natural environment (Q_3) and human environment (Q_4) in employment quality (Q) are 3.105, 2.981, 3.030 and 2.815, respectively. As per the above four observable variables, vocational college students’ employment quality score averages 2.9828.

Table 3. Indicators of digital literacy and employment quality

	Variable name	Symbol	Mean value	Standard deviation
Employment quality (Q)	Income from work	Q_1	3.105	1.037
	Labor contract	Q_2	2.981	0.986
	Work natural environment	Q_3	3.030	0.943
	Working human environment	Q_4	2.815	0.954
Digital consciousness (Y)	Numerical sensitivity	Y_1	3.472	1.051
	Number active adaptation	Y_2	2.737	0.922
	Digital value recognition	Y_3	2.988	0.876
	Digital Association	Y_4	2.683	1.331
Digital capability (L)	Digital learning ability	L_1	3.575	1.220
	Digital business ability	L_2	3.109	0.875
	Digital decision-making ability	L_3	2.739	1.007
	Digital social ability	L_4	3.683	0.997
Digital moral (V)	Digital law-abiding	V_1	3.228	1.114
	Digital security	V_2	3.078	0.886
	Digital fair use	V_3	3.119	1.336
	Digital sharing	V_4	2.835	0.937

Among the digital competence dimensions, digital social competence (L_4) scored the highest among all the variables of the dimensions with 3.575. As the vocational college students move from school to society, the change of environment may lead to real social anxiety, and digital social competence just meets the lack of emotional access in their life and helps them to integrate into the organization, gain recognition, and conduct business externally in their work. The score of digital learning ability (L_1) is the second highest among all the variables of the dimensions, vocational college students on the one hand have an active and energetic mind. Conversely, they may also succumb to the pressures of life and need to use all kinds of resources to acquire digital technology and digital knowledge to improve their livelihood skills. The score of digital business competence (L_2) is in the third place in this dimension, indicating that vocational college students are not comfortable in dealing with digital-related business in their work, and their proficiency is not enough and their efficiency needs to be improved. Digital decision-making ability (L_3), with a mean score of 2.739, has the lowest score among all the variables in this dimension, indicating that vocational college students are not yet capable of utilizing digital technology, integrating digital information, exploring digital value and making comprehensive decisions.

3.2 Regression analysis of the impact of digital literacy on employment quality

3.2.1 Regression analysis of digital literacy on employment quality

Table 4 shows the regression results of the effect of vocational college students' digital literacy development on their employment quality, where columns (1) to (3) are the regression results using individual fixed effects, time fixed effects and two-way fixed effects models, respectively, and columns (4) to (6) are the regression results with the addition of the control variables. In this regression analysis, the quality of employment is expressed in the composite index Q . The results

show that the regression coefficients for digital literacy among vocational college students are always positive and significant at the 1% level. When the control variables are included in the regression, the regression coefficients for digital literacy level remain at 0.051 to 0.153, and they are all significant at the 1% level. After all the control variables are added, the regression test coefficient of digital literacy level in the model (6) are, $R^2=5.15$, $P<0.001$.

As a whole, the increase in the level of digital literacy of vocational college students promotes the growth of their employment quality. The employment quality of vocational college students improves by approximately 0.057 (5.70%) for every unit increase in digital literacy development. This is mainly because digital literacy can determine human behavioral choices, and the improvement of digital literacy, firstly, marks the improvement of the digital sensitivity of the college student group, which can more keenly perceive the changes in the structure of the labor market in the digital era, and flow to higher-income positions. Secondly, it marks the improvement of the digital adaptability of vocational college students, which allows them to adapt better to the new business forms born from changes in digital technology. The conclusion is that digital literacy can have a significant impact on the employment quality of vocational college students.

Table 4. Baseline regression of digital literacy and employment quality

	(1)	(2)	(3)	(4)	(5)	(6)
Digital literacy	0.153***	0.051***	0.089***	0.115***	0.054***	0.057***
	12.36	4.37	7.03	9.87	4.52	5.15
Educational background	-	-	-	0.049***	0.058***	0.043***
	-	-	-	10.19	10.58	10.77
Health status	-	-	-	0.049***	0.058***	0.043***
	-	-	-	10.19	10.58	10.77
Gender	-	-	-	-0.003	-0.007	-0.005
	-	-	-	-0.012	-0.725	-0.663
Age	-	-	-	0.489***	0.478***	0.477***
	-	-	-	18.52	18.39	15.22
District	-	-	-	0.151***	0.117***	0.113***
	-	-	-	13.38	8.91	8.99
AI_i index	-	-	-	0.103***	0.108***	0.105***
	-	-	-	13.52	14.47	11.05
Social capital	-	-	-	0.031***	0.025***	0.029***
	-	-	-	3.75	2.83	2.49
Human capital	-	-	-	0.037***	0.041***	0.052***
	-	-	-	4.05	5.82	6.03
Constant term	10.232***	9.837***	9.056***	6.156***	7.119***	6.998***
	70.38	213.45	63.12	24.51	31.27	22.05
Sample size	382	386	399	344	305	325

Meanwhile, this paper examines the influence of three subdimensions of digital literacy on employment quality. Table 5 displays the regression results for the employment quality of the students, where (1) to (6) are identical to those in the previous paper. According to the findings, the regression coefficients for the digital competence level of vocational college students are all significantly

positive at the 1% level. After including all control variables in the regression and considering time-fixed effects and individual fixed effects, the regression coefficient of digital competence level is 0.112, which indicates that for every unit increase in the digital competence of vocational college students, the corresponding employment quality composite index of vocational college students rises by 11.2%.

Table 5. Baseline regression of different dimensions of digital capability

	(1)	(2)	(3)	(4)	(5)	(6)
Digital ability	0.389***	0.117***	0.156***	0.272***	0.087***	0.112***
	15.51	5.06	6.05	10.83	3.05	5.38
Digital awareness	0.399***	0.091***	0.379***	0.689***	0.767***	0.119***
	15.48	4.96	15.476	5.05	15.612	4.66
Digital ethics	1.18***	0.621***	1.197***	1.041***	1.227***	1.341***
	14.65	5.14	14.676	4.98	15.328	5.59
Control variables	-	-	-	Control	Control	Control
Sample size	382	386	399	344	305	325
Industry fixation	YES	-	YES	YES	-	YES
Fixed time	-	YES	YES	-	YES	YES

3.2.2 Test of Regression Model

1) Endogenous Test

Despite the inclusion of control variables in the benchmark regression analysis of vocational college students' employment quality, it is inevitable that the estimated results may be biased due to omission variables. The model may have a reverse causality due to the digital literacy of vocational college students, with higher employment quality being higher in the context of the intelligent age. In this paper, the endogenous problem of the model is alleviated by using a tool variable method. The tool variables selected in this article are the Internet penetration rate in the area of the sample. This is due to the higher the Internet penetration of district counties, the more people who use the Internet around the sample, resulting in "peer effects," which are associated with individual digital literacy. The external nature of the tool is ensured by the fact that the Internet penetration rate on the county level is not influenced by the quality of individual employment. The endogenous test results of the regression model are shown in Table 6. The results of the first phase of the regression show that the Internet penetration rate is related to the significant level of digital literacy of university students, which is 1%. The results of the second phase regression show that digital literacy improves the quality of students' employment at a significant level of 1%. According to the regression results, there is still a significant correlation between digital literacy and student employment quality, which is in accordance with the basic regression results. The DWH test results rejected the original hypothesis of the core interpretation variable of the core and demonstrated the need for an endogenous test.

Table 6. The endogenous test results of the regression model

Variable	(1)	(2)	(3)
	First phase	Second phase	The maximum likelihood of limited information
Digital literacy	-	0.2014***	0.2014***
	-	(0.0842)	(0.0836)
Tool variable	0.3342***	-	-
	(0.1542)	-	-
Control variable	Controlled	Controlled	Controlled
	Controlled	Controlled	Controlled
The F value of the first phase	5.8637***	-	-
DWH test	11.2536	-	-
	(0.0007)	-	-
Constant	0.5891	-0.1681	-0.1298
	(0.5019)	(0.1265)	(0.1625)
Sample size	399	399	399

2) Robustness Test

This paper uses the propensity score matching (PSM) to build the anti-factual framework, and to integrate the control variables such as age, gender, and social capital into the model, and to verify the robustness of the benchmark regression results by using the average treatment effect (ATE) of the sample match. The sample matching of the influence of digital literacy is shown in Table 7. Due to the fact that digital literacy is not a 0-1 variable, this paper will assign a number of digital literacy groups of 1, “low digital literacy” group to 0. The matching method includes the caliper, radius, and nuclear matches. The results show that digital literacy has a significant positive effect on the quality of student employment in different ways, and the results of the benchmark regression analysis are reliable.

Table 7. Estimates of PSM

Data	Employment quality	
	The nearest neighbor of the card	Radius matching
Matching mode		
Experimental group	0.6568	0.6568
Control group	0.5931	0.5914
ATT	0.0745***	0.0714***
Standard error	0.01123	0.0084
T	6.54	7.36

4 Conclusion

Utilizing survey data from 406 vocational college students in Jiangxi, this study develops a multiple regression framework to explore the role of digital literacy in enhancing employment quality. Significant outcomes are:

- 1) Digital literacy exhibits a consistently positive impact on employment prospects, with regression coefficients significant at the 1% level, ranging from 0.051 to 0.153, inclusive of control variables.
- 2) The employment quality benefit of digital literacy is underscored through robust endogenous analysis, indicating a significant enhancement at the 1% level.

The research proposes a strategic approach to uplift digital literacy among vocational students, focusing on improving digital awareness, skills, and ethics to better their employment quality.

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