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Regression Model of Factors Affecting Digital Literacy and Improvement Strategies for Vocational Bachelor's Degree Physical Education Teachers

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Abstract Enhancing the digital literacy of physical education teachers in vocational undergraduate colleges is an important part of promoting digital teaching reform and cultivating digital talents. Based on combing the concepts and components of digital literacy of physical education teachers in vocational undergraduate colleges, the article establishes a digital literacy evaluation system for physical education teachers from five dimensions: digital awareness, digital knowledge and skills, digital application ability, digital social responsibility, and professional development level. Then, based on the structural equation model estimated by partial least squares, the relevant factors affecting the digital literacy of physical education teachers in vocational undergraduate colleges were proposed from the aspects of individual, environment and behavior, and the research model of influencing factors was established. Based on distributing questionnaires and obtaining relevant data from several vocational undergraduate colleges, the overall level of current digital literacy of physical education teachers and the degree of influence of each factor on it were explored. The results showed that the average digital literacy score of physical education teachers in vocational undergraduate colleges was 4.12, the overall level of digital literacy was high, and there was a certain degree of variability among different types of physical education teachers. Individual, environment and behavior all have a significant positive effect on the digital literacy level of physical education teachers in vocational undergraduate colleges at the 1% level. Therefore, the improvement of digital literacy of physical education teachers in vocational undergraduate colleges and universities needs to strengthen the training efforts of digital technology, the reasonable use of tools to explore the value of physical education teaching in depth, and promote the internalization of digital literacy of physical education teachers.

Index Terms partial least squares, structural equation modeling, PLS-SEM, physical education teachers' digital literacy

I. Introduction

In the context of the digitalization of education, the needs and teaching modes of higher physical education are undergoing systemic changes [1]. The emerging educational ecosystem of intelligent teaching and learning environments, the characteristics of learners in the digital era, interdisciplinary course content focusing on competency development, and open supply of public services in education have posed new challenges to teachers [2]-[4]. With the rapid development of the Internet and information technology, digitalization has become an irreversible trend in education [5]. The digitalization of education is a long-term, continuous and systematic project aimed at building a good educational ecology [6]. In the context of the development of education digitization, physical education and digital technology have realized the deep integration of the whole process, and physical education teachers are the key link in this integration process [7], [8]. Higher vocational physical education teachers are the organizers, guides and participants of physical education teaching practice activities [9].

Based on this, the digital literacy of the PE teacher team in higher vocational colleges and universities, as an important position for cultivating technical and skill-oriented talents, directly affects the comprehensive quality and professional competitiveness of students [10], [11]. Digital literacy of higher vocational physical education teachers refers to the ability of higher vocational physical education teachers to use modern information technology in the teaching process, covering the mastery and application of various digital tools and resources [12]-[14]. Exploring the development of digital literacy of higher vocational physical education teachers in the context of education digitization is of great significance for college physical education teachers to adapt to the digital transformation of education and empower the development of college physical education teachers.

With the continuous development of digital technology in vocational undergraduate colleges and universities, digital literacy has become a necessary literacy for teachers to adapt to the digital society. The article selected various vocational undergraduate colleges and universities in the university city of Province T as the research object, obtained research data through the Digital Literacy Scale for Physical Education Teachers in Vocational Undergraduate Colleges and the Digital Literacy Influencing Factor Scale, and established a research model of the influencing factors of digital literacy of physical education teachers by combining the PLS-SEM model and the related research hypotheses. Based on the questionnaire data, the overall level of digital literacy of physical education teachers and the differences in digital literacy of different types of physical education teachers were explored. In response to the relevant research hypotheses proposed in the article, a path test was conducted through the PLS-SEM model, and a path to improve the digital literacy of physical education teachers in vocational undergraduate colleges was proposed.

II. Digital literacy for physical education teachers in vocational undergraduate institutions

The digitization of education has contributed significantly to modern education, especially the complete replacement of offline education by online education, further highlighting the positive effects of digitization of education on resource sharing and teaching efficiency. In order to achieve equity and modernization in education and accelerate teachers' adaptation to change, the Ministry of Education has issued an industry standard for teachers' digital literacy, which aims to enhance teachers' ability to use digital technology to acquire, process, use, manage and evaluate digital information and resources, to identify, analyze and solve educational and teaching problems, and to optimize, innovate and transform educational and teaching activities.

II. A.Digital Literacy for Physical Education Teachers

Teachers' digital literacy has been defined as their ability to use digital technologies to effectively access, process, apply, manage and evaluate digital information and resources, as well as their ability to use these technologies to identify, analyze and solve problems in education and teaching. In the process of digitization of education, teaching and learning in higher education have been transformed. Both the instructors and the taught groups bring new changes due to the new technologies, therefore, it is valuable to adjust the professional development strategies of college physical education teachers in time [15].

Digital literacy of physical education teachers in vocational undergraduate colleges and universities is a key element in the development of teachers' digital literacy in the context of digitalization of education. The Digital Literacy Standards for Teachers provide an entry point for understanding the digital literacy of physical education teachers in vocational undergraduate colleges and universities, and the general overview of digital literacy for teachers in the standards covers the relevant contents of digital literacy for physical education teachers in vocational undergraduate colleges and universities. However, because physical education teachers in vocational undergraduate colleges and universities account for a large proportion of teaching content in skill demonstration and demonstration during the teaching process, and the teaching means and methods used are significantly different compared with other disciplines, they are highly specific in terms of the scope of the specific objects and professional content involved.

Combined with existing research at home and abroad, this paper argues that digital literacy of physical education teachers in vocational undergraduate colleges and universities refers to the ability of teachers to reasonably utilize digital technological means in the process of physical education teaching in order to acquire, process, apply, manage and evaluate sports digital information and resources. This includes identifying, analyzing, and solving problems that arise in the process of physical education teaching and learning, as well as optimizing, innovating, and even reforming physical education teaching and learning activities in order to improve the quality of teaching and learning. The definition covers the awareness, competencies and responsibilities that teachers should have in the digital environment.

II. B.Digital Literacy Components

Physical education teachers in vocational undergraduate colleges are national citizens and should have the basic digital literacy necessary for nationals in the digital era, which can be abstracted into the basic level and contains three elements, namely, digital office, digital socialization, and digital security. Vocational undergraduate colleges are different from ordinary colleges and universities, which focus on cultivating applied skilled talents and mainly offer applied majors, so physical education teachers in vocational undergraduate colleges should have the digital knowledge and digital skills of their own majors, which can be regarded as the professional level, containing only one element of digitalization of their own majors.

Since entering the digital era and developing digital education, improving the digital literacy of physical education teachers in vocational undergraduate colleges and universities has become a necessary, important, and urgent need to solve the big problem. The improvement of digital literacy of physical education teachers in vocational undergraduate colleges and universities is an objective requirement for the digitalization of physical education, an inevitable need to cultivate digital high-skilled talents, and a necessary condition for the digital development of physical education teachers themselves.

The improvement of digital literacy of physical education teachers in vocational undergraduate colleges and universities directly promotes the improvement of physical education teachers' abilities in various tasks (education and teaching, practical guidance, social service, scientific research). Enhancing the digital literacy of physical education teachers in vocational undergraduate colleges is the demand of the digital era, the need for the development of vocational undergraduate colleges and universities, the requirement of their own professional development, and the inevitable growth of their personal teaching ability. And the improvement of digital literacy of physical education teachers in vocational undergraduate colleges not only helps vocational undergraduate colleges to build a digital campus environment, but also helps vocational undergraduate colleges to improve the level of digital teaching. The digital literacy of physical education teachers in vocational undergraduate colleges and the digital education of physical education in high vocational undergraduate colleges are causal, mutually promoting and positively cyclic.

II. C.Digital Literacy Evaluation Indicators

Digital literacy of physical education teachers in vocational undergraduate colleges and universities is the ability of teachers to efficiently collect information and utilize it for knowledge integration and knowledge innovation. As an important part of comprehensive literacy in the era of big data, digital literacy of physical education teachers has become an important yardstick to measure the comprehensive ability of physical education teachers. While the evaluation index system of digital literacy of physical education teachers serves as an important guide for digital literacy assessment and digital literacy education, its objectivity and scientificity are of great significance in accurately and truly understanding and grasping the current level of teachers' digital literacy of physical education teachers.

Based on this, starting from the concept of digital literacy of physical education teachers in vocational undergraduate colleges and combining its digital literacy components, this paper establishes a digital literacy evaluation index system for physical education teachers in vocational undergraduate colleges as shown in Table 1. The system mainly contains five dimensions: digital awareness, digital knowledge and skills, digital application ability, digital social responsibility and professional development level.

Table 1: Digital literacy evaluation indicators

Dimension	Explanation	Code
Digital awareness	Understand the value of digital technology	DAW1
	Understand the opportunities of the development of digital technology	DAW2
	Actively learn and utilize digital technology resources	DAW3
	Take the initiative to carry out digital education practices	DAW4
Digital knowledge and skills	Understand common digital technologies	DKS1
	Understand the principles of digital technology	DKS2
	Master digital technology resources	DKS3
	Be proficient in using digital technology resources	DKS4
Digital application ability	Digital evaluation tools can be used	DAA1
	Learn how to create digital educational resources	DAA2
	Carry out teaching by integrating digital technology	DAA3
	Optimize teaching by using digital technology	DAA4
Digital Social Responsibility	Be able to access the Internet in accordance with laws and regulations	DSR1
	Reasonable digital products and services	DSR2
	Actively maintain a healthy online environment	DSR3
	Maintain the security of work data	DSR4
Professional development level	Carry out learning by using digital technology	PDL1
	Conduct teaching practice by using digital technology	PDL2
	Utilize digital technology to support teaching activities	PDL3
	Innovate teaching models by leveraging digital technologies	PDL4

III. Modeling of factors influencing digital literacy among physical education teachers

Digitalization of education is a key factor in promoting the transformation of vocational undergraduate education from scale to substance. Physical education teachers in vocational undergraduate colleges are the key force to promote the development of physical education, and improving their digital literacy is an important path to promote the professional development of teachers, as well as the antecedent requirement to deepen the digital teaching reform of physical education in vocational undergraduate colleges. As the key to promote the reform of physical education teaching and improve the quality of teaching, the enhancement of digital literacy of physical education teachers in vocational undergraduate colleges is conducive to the innovation of physical education teaching methods and classroom modes in vocational undergraduate colleges, as well as to stimulate the motivation of vocational undergraduate colleges' students to learn, so as to improve the quality of education in vocational undergraduate colleges.

III. A. Partial least squares structural equation modeling

III. A. 1) Principles of structural equation modeling

Structural equation modeling (SEM) is a hypothetical model based on theory or experience. A causal relationship is first established, and then the collected data are used to test whether the causal relationship is valid. Structural equation modeling relies mainly on the covariance matrix for fitting, and the corresponding system of linear equations is utilized to represent the causal relationship, and the strength of the relationship can be expressed by the relationship coefficient. Variables in structural equation modeling are divided into latent variables and explicit variables, latent variables cannot be directly observed, while explicit variables can be obtained through direct observation, and two different types of paths will be formed between latent variables and between latent variables and explicit variables [16].

Latent variables include endogenous and exogenous, endogenous latent variables are affected by other variables, while exogenous latent variables only affect other variables, in the model, it can be judged by the pointing of arrows, only the ones that point to the arrows that go away are exogenous latent variables, and the ones that have arrows pointing to them are endogenous latent variables.

(1) A measurement model is a linear function of a set of explicit variables, which in SEM is a validating factor analysis used to assess the extent to which the measured variables can constitute latent variables, and to test whether the causal models of the explicit and latent variables fit the data. It is expressed in a mathematical formula as:

$$X = \Lambda_X \xi + \varepsilon \tag{1}$$

$$Y = \Lambda_Y \eta + \delta \tag{2}$$

where ξ is the exogenous latent variable, η is the endogenous latent variable, X is the matrix of explicit variables for ξ, Y is the matrix of explicit variables for η, Λ_X and Λ_Y are the matrix of loading coefficients, and ε and δ are the residuals matrix.

(2) The structural model is a function between two latent variables of internal and external causes, which can express the causal relationship between the two, and the structural model is also known as causal model or latent variable model. It is expressed by the mathematical formula:

$$\eta = B\eta + \Gamma\xi + \zeta \tag{3}$$

where B is the coefficient matrix of η, which represents the relationship between endogenous latent variables, Γ is the coefficient matrix of ξ, which is able to represent the influence of exogenous latent variables on endogenous latent variables, and ζ is the residual term.

(3) Structural equation modeling.

The measurement model and the structural model form the structural equation model, which is expressed mathematically as:

$$\begin{cases} X = \Lambda_X \xi + \varepsilon \\ Y = \Lambda_Y \eta + \delta \\ \eta = \mathrm{B}\eta + \Gamma\xi + \zeta \end{cases} \tag{4}$$

where the relevant symbols are defined as before.

III. A. 2) PLS-SEM modeling process

PLS-SEM infers relationships between variables by estimating their regression relationships.PLS-SEM is suitable for smaller samples and complex research models, and is highly flexible. Compared to CB-SEM, PLS-SEM does not require assumptions about the data distribution, making it more suitable for non-normal data and small sample studies. In addition, PLS-SEM provides a greater degree of freedom for exploratory studies and allows for the exploration of assumptions at the early stages of model development. The PLS-SEM method in this study was chosen based on the following considerations; first, the PLS-SEM method offers greater flexibility in terms of modeling and hypotheses. Second, the PLS-SEM method can be used to fit small samples of data with multiple variables, and this advantage is even more pronounced for the complex model structure with multiple latent variables in this study. Third, the PLS-SEM method is more suitable for theory development and exploratory research [17].

The modeling process of PLS-SEM can be divided into two main steps, i.e., model construction and model estimation, which is shown in Figure 1. In the model construction stage, the researcher needs to identify the potential and observed variables of the study and establish the relationship between them. Latent variables are constructs that cannot be directly observed, and observed variables are specific indicators used to measure latent variables. The theoretical foundations and previous studies allow the researcher to formulate the hypotheses and relationships in the model. In the model estimation phase, PLS-SEM uses partial least squares to estimate model parameters. Partial least squares estimates model parameters by minimizing the covariance between latent and observed variables. PLS-SEM decomposes the model into a structural model and a measurement model. In the structural model, PLS-SEM reveals causal relationships between variables by estimating regression relationships between latent variables. It gradually adjusts the weights between the latent variables through an iterative process to optimize the fit of the model. In measurement modeling, PLS-SEM determines the fitness of the measurement model by estimating the relationship between observed variables and latent variables. It measures the explanatory power of the observed variables to the latent variables by calculating the loading factors. Finally, PLS-SEM quantifies the strength of the relationship between the variables by calculating path coefficients.

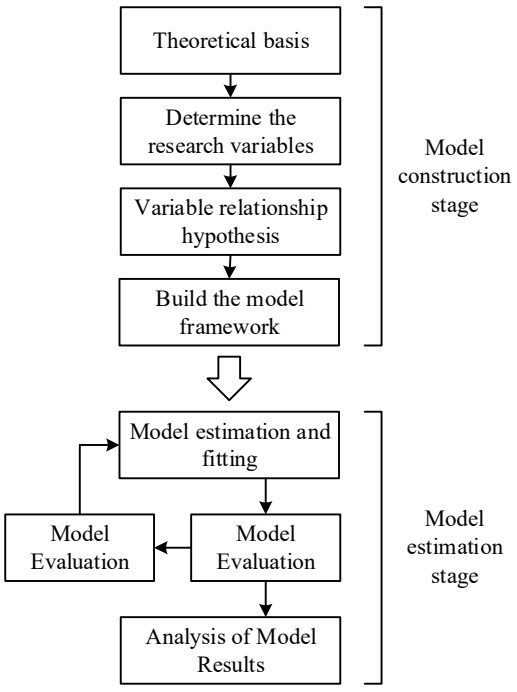

Figure 1: Modeling process of PLS-SEM

III. B. Model of factors influencing digital literacy

III. B. 1) Theoretical assumptions on impact factors

For the influencing factors of digital literacy of physical education teachers in vocational undergraduate colleges, this paper mainly analyzes them from three dimensions: personal factors, environmental factors and behavioral factors.

(1) In the personal factors affecting physical education teachers' digital literacy, it is mainly analyzed from the three dimensions of self-efficacy, digital technology experience and intrinsic driving force. Self-efficacy promotes

physical education teachers to actively use digital technology to carry out physical education activities, and the existing digital technology experience enhances the physical education teachers' awareness of the application of digital technology, which can provide a reference for the digital transformation of physical education. Under the intrinsic driving force of physical education teachers, the transformation of teachers from the “leader” of the classroom to the “enabler” of student learning in the digital era will be realized.

Based on this, this paper puts forward the following hypotheses:

H1: Physical education teachers' self-efficacy will significantly increase their digital literacy level.

H2: Physical education teachers' experience with digital technology will significantly increase their digital literacy level.

H3: Physical education teachers' intrinsic drive will significantly enhance their digital literacy level.

(2) Among the environmental factors affecting physical education teachers' digital literacy, this paper focuses on analyzing the role of organizational support and digital technology training in schools. Within the school organization, the concept of digital literacy of educational administrators also affects the improvement of teachers' digital literacy. Currently, schools still pay more attention to students' test scores, resulting in teachers only being able to put the improvement of teachers' digital literacy and empowering the digital literacy of the educated on the back burner. School organizational support shows a positive correlation with highlighting the value of digital teaching and learning efforts and driving teachers' digital literacy enhancement. Diversified digital technology training can significantly enhance physical education teachers' favorability of digital technology, thus better helping physical education teachers to integrate digital technology into their daily physical education teaching activities.

Based on this, this paper proposes the following hypotheses:

H4: Organizational support in schools will significantly enhance physical education teachers' digital literacy.

H5: Digital technology training will significantly increase the level of digital literacy of physical education teachers.

(3) Among the environmental factors affecting physical education teachers' digital literacy, the article focuses on the specific effects of open learning, self-correction and interpersonal communication. Physical education teachers actively carry out open learning, the essence of which is to enhance their open-minded thinking, so as to better accept the application of digital technology. Self-correction, to a greater extent, shows the self-examination and summarization ability of physical education teachers in the process of teaching, which helps physical education teachers to understand the deficiencies in teaching and actively explore the innovative modes of physical education teaching under the new technology support. Interpersonal communication shows that physical education teachers use social media to assist the realization of physical education teaching activities, to better transfer the relevant knowledge and skills of physical education courses, and to lay a solid foundation for the establishment of a learning community.

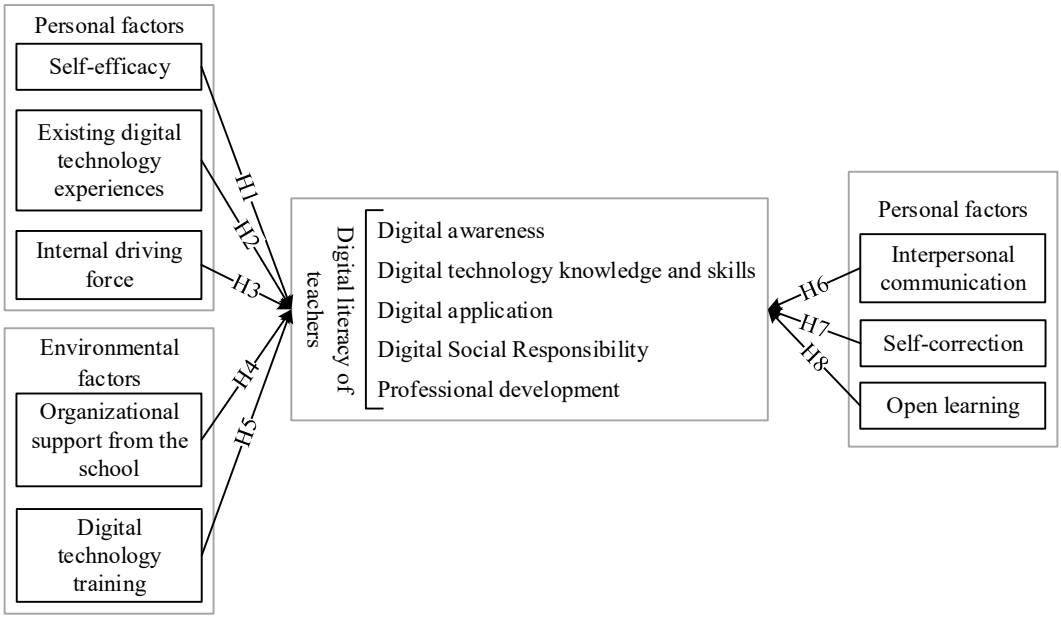

Figure 2: Research model of influencing factors

Based on this, this paper proposes the following hypotheses:

H6: Physical education teachers' interpersonal communication skills will significantly enhance their digital literacy level.

H7: Physical education teachers' self-correction ability will significantly enhance their digital literacy level.

H8: Physical education teachers' open learning habits will significantly enhance their digital literacy level.

III. B. 2) Impact factor research model

Based on the eight different types of influencing factors under the three dimensions given in the previous section, combined with the PLS-SEM model, this paper establishes a model of influencing factors for digital literacy of physical education teachers in vocational undergraduate colleges as shown in Figure 2.

III. C. Questionnaire design and distribution

III. C. 1) Digital Literacy Influencing Factors Scale

For the digital literacy influencing factors of physical education teachers in vocational undergraduate colleges, based on the research hypotheses given in the previous section, this paper designs the Digital Literacy Influencing Factors Scale for Physical Education Teachers in Vocational Undergraduate Colleges. The questionnaire mainly contains three parts, the first part is the basic personal information, including gender, age, teaching age, title, teaching subject, teaching grade, education and geographical location of the school, with a total of eight items in the form of single-choice questions. The second part is a survey on the current status and influencing factors of physical education teachers' digital literacy, which appears in the form of single-choice questions, in which five dimensions are set in the section of the current status of physical education teachers' digital literacy, and the details can be seen in the previous section of the evaluation index system of physical education teachers' digital literacy. The part of physical education teachers' digital literacy influencing factors is set up in 3 dimensions, i.e. personal factors, environmental factors and behavioral factors. The third part is related to the digital literacy of physical education teachers in the form of multiple choice questions. The questionnaire was based on a five-point Likert scale, and the respondents answered the questions according to their personal compliance with the descriptions of the questions, in which a score of 3 or less indicated a low level of digital literacy among physical education teachers. A score between 3 and 4 indicates a moderate level of digital literacy among physical education teachers. A score of 4 or more indicates a high level of digital literacy among physical education teachers. The questionnaire was scored and counted using SPSS software.

III. C. 2) Study Population and Questionnaire Distribution

The research object of this paper is the vocational undergraduate colleges and universities in the university city of T province, and the questionnaire is conducted online through questionnaire star. In this paper, a total of 741 questionnaires were obtained, and the invalid questionnaires were screened out for filling in too short a period of time, failing to pass the screening questions, etc., and finally 725 valid questionnaires were obtained, with a valid questionnaire percentage of 97.84%. The proportion of male teachers in the survey sample is higher than that of female teachers, accounting for 82.7%. In terms of age distribution, teachers aged 30-35 account for the most, and in terms of education, teachers with master's degree account for 85.62%. In terms of title distribution, the proportion of associate senior teachers is 42.07%, which is the largest group. In terms of teacher type, full-time type teachers on campus accounted for the majority (74.28%). In addition, 75.86% of the physical education teachers indicated that they had achieved some results using digital technology.

IV. Analysis of factors influencing digital literacy among physical education teachers

In contemporary society, where information technology is developing rapidly, it has become the norm to utilize digital technology to accomplish daily work and learning tasks. Digital technology has become more and more common in all aspects of human social life, has been the necessary skills for people to achieve competitiveness. It not only promotes the digital transformation of the economy and society, but also subtly changes people's way of thinking and lifestyle. In this context, it is obvious that digital literacy of physical education teachers will become an important issue in the professional development of physical education teachers and in the field of physical education teacher education research.

IV. A. Descriptive statistical analysis of data

IV. A. 1) Overall level of digital literacy among physical education teachers

In order to ensure the rigorous scientific nature of the result analysis, the sample data were tested for normality using the K-S test, and the results showed that the sample data showed a normal distribution. Then the overall level of digital literacy of physical education teachers in vocational undergraduate colleges was statistically analyzed by descriptive statistics, and its specific results are shown in Table 2. Based on the results in the table, it can be seen that the average score of digital literacy of physical education teachers in vocational undergraduate colleges is 4.12

(out of 5), which can be seen in combination with the evaluation criteria given in the previous section, and the level of digital literacy of physical education teachers in vocational undergraduate colleges is higher at present.

In terms of specific digital literacy level dimensions, physical education teachers in vocational undergraduate colleges perform best in digital social responsibility, with a mean score of 4.46. Digital social responsibility is the ethical measure of physical education teachers' digital literacy, and it is also the measure of physical education teachers' behavior on social media, which indicates that physical education teachers actively comply with information technology-related laws and regulations and have a strong awareness of overall digital security protection. The professional development level and digital awareness dimensions were the next highest, with mean scores of 4.17 and 4.15 in that order. Digital technology knowledge and skills and digital application ability scored the lowest, with mean values of 3.98 and 3.84 in turn. Digital technology knowledge and skills and digital application are the weakest aspects of digital literacy among physical education teachers in vocational undergraduate colleges, and they are both lower than the overall mean score, indicating that physical education teachers in vocational undergraduate colleges have low competence in these two dimensions, which pulls down their overall digital literacy level.

Table 2: Digital literacy of physical education teachers

Dimension	Min	Max	Means	Skewness	Kurtosis
Digital awareness	3.58	5.00	4.15	-0.842	0.108
Digital knowledge and skills	3.06	4.83	3.98	0.316	0.225
Digital application ability	2.87	4.95	3.84	-0.763	-0.319
Digital Social Responsibility	3.72	5.00	4.46	0.274	0.284
Professional development level	3.49	4.86	4.17	0.363	0.127
Total	3.34	4.93	4.12	-	-

IV. A. 2) Statistical analysis of variation by type

The digital literacy of physical education teachers in vocational undergraduate colleges was affected by the demographic factors of the teachers, and the effects of gender, teaching age, title, and type of course on the level of digital literacy of physical education teachers in vocational undergraduate colleges were counted, the specific results of which are shown in Table 3. In the table, *,** indicates that the difference is statistically significant at the 5% and 1% levels, respectively.

First, gender. The differences in digital awareness, digital technology knowledge and skills, digital application, digital social responsibility, and professional development scores of teachers of different genders are not statistically significant, indicating that gender differences do not affect the level of teachers' digital literacy.

Second, teaching age. The differences in scores between teachers of different teaching ages were statistically significant in terms of digital social responsibility (F=3.04, P=0.012<0.05) and professional development (F=3.79, P=0.002<0.01). Further analysis revealed that teachers with less than 5 years of teaching experience had significantly higher scores on digital social responsibility than teachers with 10 to <15 years of teaching experience and teachers with ≥20 years of teaching experience, as well as significantly higher scores on professional development than teachers with 5 to <10 years of teaching experience and teachers with 15 to <20 years of teaching experience. In contrast, teachers with high teaching age ≥20 years were less aware of digital security protection and less capable of handling cybersecurity issues.

Third, job title. In terms of digital social responsibility (F=4.03, P=0.002<0.01), the difference in the scores of teachers with different job titles was statistically significant. Further analysis revealed that teachers with the title of assistant professor scored significantly higher on digital social responsibility than teachers with the title of full senior. Through interviews, it was learned that teachers with the title of full senior were relatively weak in digital social responsibility because they were usually more focused on traditional teaching and research work and paid less attention to digital technology.

Fourth, course type. Statistically significant differences in scores between faculty members of different course types were found in digital technology and knowledge (F=2.87, P=0.037<0.05), digital applications (F=3.05, P=0.024<0.05), and professional development (F=2.98, P=0.039<0.05). Further analysis revealed that teachers in the Track and Field Gymnastics group scored significantly higher than the other groups in terms of digital technologization and knowledge. Teachers in the Track and Field Gymnastics group scored significantly higher than the Aerobics and Dance group and the other groups in terms of digital application, as well as significantly higher in terms of professional development than the Martial Arts Combat group, the Aerobics and Dance group, and the other groups. The reason for this is that the track and field gymnastics course has a greater demand for digital technology, and the display of the body's movement trajectory often requires the help of digital equipment, such as

wearable devices and motion analysis systems, in order to help students establish a more intuitive and scientific concept of technical movements in track and field gymnastics, so that students can better understand.

Table 3: The scores of digital literacy levels among teachers of different types

Dimension	Item	DAW	DKS	DAA	DSR	PDL
Sex	Male	4.02	3.42	3.11	3.95	3.51
	Female	3.92	3.37	3.06	3.84	3.36
	t	1.15	0.65	0.22	1.15	1.98
Teaching experience	<5	3.94	3.47	3.28	4.18*	3.62**
	5~<10	3.82	3.43	3.06	3.75	3.43
	10~<15	4.03	3.54	3.15	3.97	3.61
	15~<20	3.76	3.22	2.98	3.71	3.26
	>20	4.12	3.37	3.06	3.65	3.41
	F	2.18	1.03	1.22	3.04	3.79
Title	Assistant	3.82	3.47	3.27	4.18**	3.58
	Lecturer	3.94	3.37	3.04	3.92	3.42
	Associate senior	4.06	3.42	3.15	3.96	3.47
	Zhenggao	4.02	3.36	2.94	3.45	3.13
	F	1.67	0.18	1.69	4.03	1.64
Teaching type	Sports theory	4.25	3.35	3.26	4.11	3.61
	Ball games	4.06	3.47	3.15	4.06	3.52
	Track and field	3.91	4.08*	3.84*	4.45	4.06*
	gymnastics	3.84	3.46	3.15	3.84	3.37
	Martial arts combat	3.79	3.32	2.94	3.86	3.25
	Aerobics dance	3.98	3.16	2.86	3.82	3.34
	F	1.25	2.87	3.05	1.48	2.98

IV. B. Reliability test of the questionnaire

IV. B. 1) Questionnaire reliability test

Before analyzing the digital literacy questionnaire for physical education teachers in vocational undergraduate colleges, it is necessary to carry out a reliability test for the questionnaire and scale, and only the questionnaire that passes the reliability test can ensure the scientific nature of variable measurement and data analysis. In this paper, Cronbach's alpha reliability coefficient is used as the index of reliability test, which is the most commonly used index for reliability analysis.Cronbach's alpha coefficient is mainly used to assess the degree of consistency of the scores of each topic in the scale, which belongs to the category of internal consistency coefficient. This method is usually applied to the reliability analysis of attitude and opinion-based questionnaires or scales. Generally speaking, the reliability coefficient of a scale should be above 0.85, and between 0.75 and 0.85 is also acceptable. If the Cronbach's alpha coefficient is below 0.65, the questionnaire needs to be considered for reformulation. Table 4 shows the results of the reliability test of the questionnaire, in which CITC indicates the total correlation of the corrected items and Delete indicates the Cronbach's α coefficient of the item has been deleted.

As can be seen from the table, the Cronbach's α coefficients of the dimensions under the level of digital literacy of physical education teachers in vocational undergraduate colleges are higher than 0.8, and the Cronbach's α coefficient of their overall scale is 0.941. In addition, the Cronbach's α coefficients of the personal, environmental and behavioral under the influencing factors of the physical education teachers' digital literacy are respectively 0.886, 0.928 and 0.931, which are all higher than the 0.85 standard value. Therefore, it shows that the internal heterogeneity of the digital literacy scale and digital literacy influencing factors scale for physical education teachers designed in this paper is good, and the results of the survey data obtained from this questionnaire have excellent reliability and can be used for subsequent research.

IV. B. 2) Questionnaire validity test

The validity analysis of the questionnaire measures the degree of consistency between the variables and the scale data, and mainly contains two kinds of aggregation validity and differentiation validity.

(1) Convergent validity reflects the degree of convergence of latent variables corresponding to each observed variable, which is mainly measured by factor loadings (FL), combined reliability (CR) and average variance extracted (AVE). Among them, factor loadings and combination reliability are required to be greater than 0.65, and the average variance extracted is greater than 0.6, which indicates a high degree of aggregation validity. In this study, the

analysis of the aggregation validity was done using SPSS software and the results of the analysis are shown in Table 5.

The factor loadings of all question items were greater than 0.65 and showed significance, implying a good measurement relationship. The combined reliability of all dimensions is greater than 0.91, which is considered that the questions under the same dimension have internal consistency, and the mean variance extraction of all dimensions is above 0.65, which can indicate that the data of the dimensions of this questionnaire have good convergent validity.

Table 4: Questionnaire reliability test

-	Name	CITC	Delete	Cronbach's α
Digital literacy	Digital awareness	0.872	0.917	0.941
	Digital knowledge and skills	0.824	0.942	
	Digital application ability	0.805	0.938	
	Digital Social Responsibility	0.819	0.927	
	Professional development level	0.843	0.915	
Personal factor	Self-efficacy	0.814	0.826	0.886
	Digital technology experiences	0.849	0.853	
	Internal driving force	0.835	0.847	
Environmental factor	Organizational support	0.862	0.903	0.928
	Digital technology training	0.816	0.915	
Behavior factor	Open learning	0.892	0.906	0.931
	Self-correction	0.843	0.938	
	Interpersonal communication	0.815	0.924	

Table 5: Aggregate validity summary table

-	Name	FL	CR	AVE
Digital literacy	Digital awareness	0.803	0.916	0.742
	Digital knowledge and skills	0.862		
	Digital application ability	0.875		
	Digital Social Responsibility	0.801		
	Professional development level	0.849		
Personal factor	Self-efficacy	0.752	0.934	0.691
	Digital technology experiences	0.864		
	Internal driving force	0.774		
Environmental factor	Organizational support	0.810	0.978	0.752
	Digital technology training	0.803		
Behavior factor	Open learning	0.852	0.921	0.793
	Self-correction	0.732		
	Interpersonal communication	0.874		

(2) Distinguishing validity is a measure of the degree to which a latent variable is distinct from other latent variables, and this study used the Vernell-Lark criterion for the analysis of distinguishing validity. The Vernell-Lack criterion is judged by the square root of the average variance extracted (AVE), and the correlation coefficients between the dimensions are smaller than the square root of the AVE. Table 6 shows the results of the analysis of the Vernell-Lark criterion, the diagonal diagonal line in the table is the AVE square root value, and the rest of the values are correlation coefficients.The AVE square root value can indicate the aggregation of variables, and the correlation coefficient indicates correlation, and if the aggregation of the variables is significantly stronger than the absolute value of the correlation coefficient with the correlation coefficients between the other variables, then it can indicate that there is a discriminatory validity. From the table, it can be seen that the AVE square root values of each dimension in this study are greater than the correlation coefficients between the latent variable and other variables, so the measurement model has good discriminant validity.

Regarding the problem of multicollinearity, which refers to the high degree of correlation between the variables in a linear regression model that leads to distortion of the estimation of the measurement model or a decrease in the

accuracy of the estimation, existing studies have proposed that when the value of the variance inflation factor (VIF) is greater than or equal to 5, it indicates that there is a serious covariance problem between the measured variables. In this study, multiple covariances were tested and the results are shown in the lower five rows in Table 6, where the VIF values for each dimension are below 5, indicating that there is no covariance problem among the variables.

Table 6: Result of Discriminative validity

-	DL	PF	EF	BF
DL	**0.861**	-	-	-
PF	0.428	**0.831**	-	-
EF	0.517	0.449	**0.867**	-
BF	0.495	0.486	0.391	**0.891**
-	AL	_KSL	UL	**EL**
DL	1.624	1.624	1.624	1.624
PF	1.578	1.578	1.578	1.578
EF	1.396	1.396	1.396	1.396
BF	1.463	1.463	1.463	1.463

IV. C. Analysis of structural equation modeling tests

IV. C. 1) Results of fitting the structural equations

Structural equation modeling is a statistical analysis method that integrates factor analysis and path analysis, and is widely used in influence factor research. This method is suitable for statistical analysis of large samples, and the sample data must meet the normal distribution, the sample size of the questionnaire survey in this study reached 725, and the normality of the sample data was tested. Therefore, the data of this study are suitable for statistical analysis using structural equation modeling.

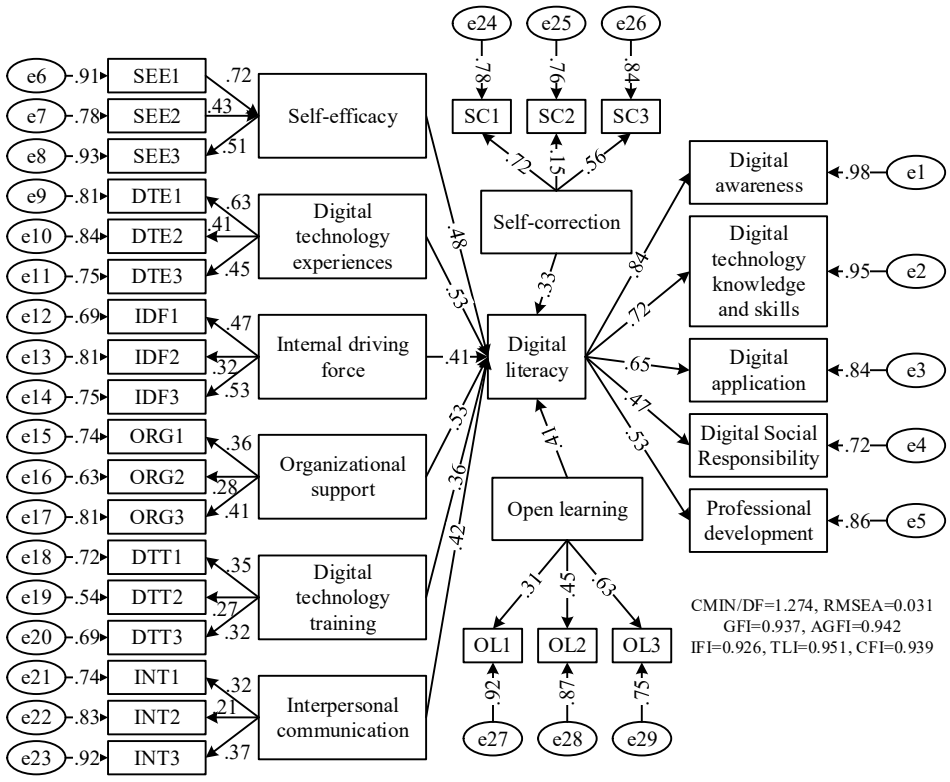

Figure 3: The fitting result of the structural equation

In this study, the eight influencing factors of digital literacy of physical education teachers in vocational undergraduate colleges (personal, environmental and behavioral factors) were used as the independent variables, and digital literacy of physical education teachers was used as the dependent variable, and all these seven variables were latent variables. The question items corresponding to each influencing factor in the Influencing Factor Scale

for Physical Education Teachers in Vocational Undergraduate Colleges and Universities were taken as the measurement indexes of each influencing factor, and the dimensions in the Digital Literacy Level Scale for Physical Education Teachers in Vocational Undergraduate Colleges and Universities were taken as the measurement indexes of digital literacy. The structural equation model constructed by using AMOS software and combining the hypothetical model of the influencing factors is shown in Figure 3.

After the structural equation modeling is completed, it is necessary to evaluate and test for the structural equation model fitness. The fitness indicators such as CMIN/DF, RMSEA, GFI, AGFI and the corresponding judgment criteria are commonly used to carry out the fitness test of the structural equation model. Based on the fitness indicators in the figure, it can be seen that CMIN/DF=1.274 (1<CMIN/DF<3, indicating that the model has a degree of parsimonious fitness), RMSEA=0.031 (the closer the value of the indicator is to 0, the better the model fitness is, and <0.05 and <0.08 indicate a good and reasonable fit, respectively). GFI, AGFI, IFI, TLI and CFI are 0.937, 0.942, 0.926, 0.951, 0.939 respectively (the closer the values of the above five indexes are to 1, the better the model fit is, of which >0.85 and >0.75 indicate a good fit and a reasonable fit respectively). It can be seen that the structural equation model of digital literacy of physical education teachers in vocational undergraduate colleges established in this paper has better fitness indicators, and all fitness indicators have reached the standard of good fitness, which can truly reflect the specific impact of various factors on the digital literacy of physical education teachers in vocational undergraduate colleges.

IV. C. 2) Research hypothesis path testing

Based on the above premise of good model fit, the hypotheses of this study are tested to see if they are valid, and the results of hypothesis testing for specific structural equation models are shown in Table 7. Beta, S.E. and *** in the table indicate the path coefficients, standardized error and the existence of significance at 1% level, respectively. It can be seen that the S.E value of each path is greater than 0, and the significance of H1~H8 is P<0.01, i.e., it presents significance at 1% level. This shows that the H1~H8 hypotheses of this study are valid.

Among the personal factors, H1~H3 denote the self-efficacy, digital technology experience and intrinsic drive of PE teachers in vocational undergraduate colleges and universities, respectively, which all promote the enhancement of PE teachers' digital literacy, with the path coefficient values of 0.481, 0.527, and 0.409, respectively, with P<0.01. This suggests that a good self-efficacy as well as intrinsic drive will enhance PE teachers' digital technology desire, thus improving their digital literacy.

Among the environmental factors, H4~H5 indicated the influence of school organizational support and digital technology training on physical education teachers' digital literacy, respectively, and the path coefficients of the two were 0.532 and 0.364, in which the influence of school organizational support was relatively greater. This also fully explains that if we want to improve the digital literacy of physical education teachers in current vocational undergraduate colleges and universities, we need the schools to actively expand the relevant digital technology equipment as a way to meet the digital physical education teaching needs of physical education teachers.

Among the behavioral factors, H6~H8 represent physical education teachers' interpersonal communication ability, self-correction ability and open learning habits, respectively, with path coefficients of 0.418, 0.326, and 0.413, which all have a significant positive effect on physical education teachers' digital literacy at the 1% level. Based on this, in the process of physical education teachers' behavioral expression, they need to carry out daily introspection on their own teaching behaviors and accept the application of digital technology in physical education teaching in combination with an open learning mindset, so as to enhance their own digital literacy, and to provide guidance for the digital reform of physical education in vocational undergraduate colleges and universities.

Table 7: The result of Study the hypothesis path test

-	Path	Beta	S.E.	C.R.	*P*	Result
H1	SEE→DL	0.481	0.032	8.279	***	Establish
H2	DTE→DL	0.527	0.051	7.651	***	Establish
H3	IDF→DL	0.409	0.038	6.512	***	Establish
H4	ORG→DL	0.532	0.062	4.274	***	Establish
H5	DTT→DL	0.364	0.027	6.115	***	Establish
H6	INT→DL	0.418	0.043	5.428	***	Establish
H7	SC→DL	0.326	0.065	7.969	***	Establish
H8	OL→DL	0.413	0.057	5.423	***	Establish

V. Conclusions and recommendations

V. A. Conclusion

Based on the questionnaire data from several vocational undergraduate colleges, the article explored the relevant factors affecting the digital literacy of physical education teachers in vocational undergraduate colleges by combining the PLS-SEM model. Overall, the average digital literacy score of physical education teachers in vocational undergraduate colleges was 4.12, the digital literacy level of physical education teachers was high, and there was some variability in the digital literacy of physical education teachers with different teaching ages, titles and course types. In addition, personal factors (self-efficacy, digital technology experience, intrinsic drive), environmental factors (school organizational support, digital technology training) and behavioral factors (interpersonal communication, self-correction, and open learning) all had a positive effect on physical education teachers' digital literacy at the 1% level.

V. B. Recommendations

(1) Strengthening digital technology training

With the rapid development of information technology, digital literacy has become an integral part of teachers' professional growth. In order to better respond to the wave of informatization in the field of education, it has become crucial to enhance the information technology ability of higher education physical education teachers.

First of all, it is necessary to strengthen the training component of the digital literacy enhancement program. The specific implementation plan may include organizing professional training courses on digital literacy on a regular basis and inviting renowned experts in the industry, scholars in the field of educational technology and teaching staff with rich practical experience to give face-to-face lectures and hands-on demonstrations. Such training should extensively cover the latest information technology application cases, digital teaching methods and concepts, etc., so as to ensure that higher vocational physical education teachers can keep pace with the development of the times.

Secondly, in addition to regular professional training courses, support and funding should be provided for senior PE teachers to participate in various professional refresher courses, postgraduate courses and domestic and international seminars aimed at improving digital skills. Such activities will not only help teachers keep abreast of the development trend of education informatization, but also continuously enhance their digital competence and teaching standards. For senior physical education teachers who have made significant achievements in improving their digital literacy, it is recommended that a special award fund be set up to recognize their contributions and further motivate them.

Finally, in order to build a motivational mechanism that can continuously motivate higher-level PE teachers to improve their digital skills, it is particularly important to develop a comprehensive set of digital literacy evaluation criteria and assessment system. The assessment results should be closely related to teachers' career development opportunities and performance evaluations to ensure that they continue to hone and improve their digital competence in their daily teaching practice. Adopting this strategy not only enhances the motivation of physical education teachers to integrate information technology into classroom teaching, but also promotes the innovation of physical education teaching methods as well as the improvement of overall teaching quality.

(2) Rational use of tools to explore the value of teaching in depth

In the digital era, data has become an important booster for physical education. Physical education teachers should master efficient data collection methods and use intelligent devices and learning platforms to capture students' sports performance, physical status and learning trajectory. What's more, they should cultivate the ability of data analysis to extract key information from massive data, such as students' sports potential and learning difficulties, so as to build a solid foundation for personalized teaching.

First of all, teachers need to master efficient data collection skills, not only to be familiar with the use of smart devices and learning platforms, but also to be able to flexibly utilize these tools to comprehensively record students' athletic performance, physical status and learning trajectories. The speed of every run, the height of every jump, and the sweat and effort put in every time should all be recorded in detail. These data are like pieces of a jigsaw puzzle that can build a complete picture of each student, providing teachers with a rich source of information. Secondly, teachers also need to have strong data analysis skills to be able to extract key information, such as students' athletic potential and learning difficulties, from the massive amount of data. This requires teachers not only to master the operation of data analysis software, but also to have a keen insight into data. Through deep mining, teachers are able to discover students' flashpoints and deficiencies, providing strong support for personalized teaching. Based on the results of accurate data collection and deep mining, teachers can develop more targeted teaching strategies and training programs. Finally, teachers should carefully design curriculum content and teaching methods according to students' physical differences and learning needs, and strive to teach students according to their aptitude and accuracy. This data-driven teaching model not only improves the relevance

and effectiveness of teaching, but also greatly stimulates students' interest and enthusiasm. At the same time, teachers should continuously adjust their teaching strategies through the instant feedback mechanism to ensure the successful realization of teaching goals.

(3) Promote the internalization and sublimation of teachers' digital literacy

The results of this study show that physical education teachers in vocational undergraduate colleges have generally possessed a high degree of awareness of digital teaching and fully recognize the importance of digital technology in teaching, therefore, physical education teachers in vocational undergraduate colleges need to further internalize digital literacy, so as to make digital literacy become the “meta-literacy” of physical education teachers.

First, realize the gradual transformation from “tool” to “way”. Digital technology is not only a teaching aid, but also a mindset that reshapes the teaching mode by revolutionizing the way of teaching. Therefore, on the basis of good digital attitudes and awareness, physical education teachers in vocational undergraduate colleges and universities should cultivate a digital teaching mindset, improve their sensitivity, initiative and creativity in solving teaching problems by digital means, establish digital ethics and morality, form a systematic concept of digital education, and break the stereotypical idea that information technology is only an auxiliary means of teaching.

Secondly, to strengthen the sense of identity of physical education teachers in vocational undergraduate colleges as “digital teachers”. In order to cope with the changes in the emerging digital environment, the concept of “digital citizenship” was born, which refers to the citizenship of learning, working and living in the virtual space using digital technology. Vocational undergraduate colleges and universities should also establish the identity concept of “digital teacher” for physical education teachers, form a unified value and cognitive model in the context of digital teaching reform, strengthen the sense of identity and psychological belonging, and enable physical education teachers to consciously improve their digital literacy and digital teaching skills.

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