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An Analysis of Key Factors of the Community of Inquiry Framework in Virtual Teaching and Research Communities Based on the CRITIC Weighting Method and Multiple Linear Regression and Its Impact on Teachers' Professional Development Research

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ABSTRACT

Virtual teaching and research community is an effective way for teachers to realize communication and cooperation among themselves, to improve their professional level and to promote their career development. Under the framework of teaching and research community community construction, the relevant factors that resound the development of virtual teaching and research community construction were extracted by questionnaire survey method, CRITIC-assigned to them, and the factors with larger weights were taken as the key factors, and the multiple linear regression method was utilized to explore their influence on teachers' professional development. The analysis found that the key factors with larger weights are teaching and research team building (0.3234) and teaching and research motivation (0.2683), and the regression coefficients of both of them in the regression results of teachers' professional knowledge and professional skills are 0.18, 0.158, and 0.089, 0.059, respectively, and the significance of all of them is less than 0.05. Therefore, the teaching and research team building and teaching and research motivation are not only crucial to virtual teaching and research community operation, but also have a positive effect on teachers' professional development.

Keywords: CRITIC weighting method, multiple linear regression, virtual teaching and research community, teachers' professional development

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1. Introduction

Nowadays, teachers are in the era of rapid development of Internet technology, their lifelong learning has become inevitable, and the development of the teacher's profession has also received widespread attention. Although, the national, provincial and municipal levels of education departments have carried out various types of training activities for this purpose, but short-term centralized training, expert lectures can not fully meet the needs of teachers' long-term teaching practice on the theoretical knowledge of education and teaching, teaching skills [1-2]. As teachers' learning, teaching and research, practice, reflection and other activities do not exist separately, but are interconnected and mutually reinforcing, only by playing a role together can we effectively improve the level of teachers' education and teaching, and enhance the effectiveness of classroom teaching [3-5]. When teachers' daily independent learning, teaching seminars and timely access to help and guidance from experts and peers are met, only then can they truly promote the overall development of teachers [6-8]. Therefore, the establishment of a place for teachers to learn, teach and research, communicate and reflect anytime and anywhere has become one of the ways to effectively support teachers' professional development.

Relying on modern network technology, the virtual teaching and research community can provide an open, dynamic and interactive network teaching and research platform for teachers' professional development [9-10]. It has many advantages, not only providing a good platform for knowledge management and teaching reflection, but also uniting education experts and professional teachers to form a teacher teaching and research community to realize resource sharing and experience exchange [11-14]. In the virtual teaching and research community, ordinary teachers will successfully complete the “socialization” process of transforming into professional teachers and realize the construction of practical knowledge [15-16]. The establishment of a sustainable virtual teaching and research community can improve teachers' professionalism and realize their professional development through carrying out learning activities, seminars, practical activities and reflective activities related to education and teaching [17-19].

This study defines and characterizes the virtual teaching and research community, and proposes an implementation framework for community building in the virtual teaching and research community. In order to explore the key factors in the operation and construction of virtual teaching and research communities, this paper firstly divided the multiple factors derived from the questionnaire survey into fine-grained and coarse-grained, and solved the weights of the multiple factors using the CRITIC weighting method. A number of factors with larger weights were selected as key factors, combined with other factors that may affect teachers' professional development as independent variables, and teachers' professional knowledge and skills as dependent variables, and the impact of each variable on teachers' professional development was examined using multiple linear regression to test the influence of the operation of the Virtual Teaching and Research Community on the development of teachers' professional literacy.

2. Framework for building virtual teaching and research communities and neighborhoods

2.1. What is a virtual teaching and research community

Virtual teaching and research is a method of utilizing modern information technology, based on the Internet, to promote cross-time and space teaching and research activities carried out by teachers in different geographical areas, to exchange teaching results and experiences and share teaching information and resources with each other at any time and any place [20]. The sociological interpretation of community is a social community formed by social groups and social organizations gathered in a certain geographical area that are interrelated in life [21]. Virtual teaching and research

community is a virtual teaching and research community that aims to promote teachers' professional development and teaching reform, is problem-oriented, and takes subject teachers as the main body, and relies on the network environment to realize the exchange of experience, knowledge management, resource sharing and network interaction.

2.2. Characteristics of the virtual teaching and research community

2.2.1. Shareability. As the level of educational informatization continues to improve, more and more teachers are designing and developing informatized teaching resources. Compared with traditional teaching resources, informatized teaching resources are easier to organize, manage, find and deliver, which makes the sharing of quality teaching resources very convenient. Many front-line teachers make full use of this when preparing lessons, they download suitable teaching resources on the Internet, and use them to learn from and improve their own teaching design. At the same time, they can also upload their own teaching resources to the Internet for others to share, fully embodying the sharing spirit of "all for one, one for all".

2.2.2. Interactivity. The virtual teaching and research community relies on the online environment and is highly interactive. Pre-service teachers, post-service teachers, and education experts can all interact and communicate at any time and anywhere through the various communication tools provided online. The virtual teaching and research community can greatly shorten the distance between the interacting subjects, thus realizing a multi-win situation: through equal interaction between education experts and front-line teachers, the theoretical research of the former can be tested in the latter's teaching practice, and the latter's experience in teaching practice can be summarized in a timely manner, so as to reconfigure their own educational concepts. Pre-service teachers, on the other hand, may benefit even more, as they can communicate with both front-line teachers and education experts, refining their own theories of teaching and learning and sharing the practical teaching experience of front-line teachers.

2.2.3. Community. The virtual teaching and research community is a social network that emphasizes user contribution and participation. The reticence of teachers' practical knowledge means that it can only be realized, not transmitted. In a community-based virtual teaching and research community, pre-service teachers form a teaching and research community with frontline teachers and education experts, gradually "socializing" themselves through sharing and interaction, and constructing practical knowledge in a subtle way.

2.2.4. Personalization. The virtual teaching and research community has its communal nature as a whole and personalized characteristics on an individual basis. More and more grassroots teachers have started to have their own social accounts, on which they post their own teaching designs, teaching reflections, educational narratives, and even their own classroom accounts. These personalized teaching resources are fundamentally different from traditional teaching resources; they are a true portrayal of teachers' personalized teaching experiences and an explicit carrier of their implicit practical knowledge. For educational experts, they are raw materials for research, while for pre-service teachers, they are an important source of practical knowledge.

2.3. Framework for building a community of virtual teaching and research communities

2.3.1. Seek external support. As an informal organization of teachers' groups within a school, the recognition and support of the school authorities is an important factor in the sustainability of the community. The virtual teaching and research community reported to the head of the university in charge of teaching and the functional department in charge of teaching as soon as the initial plan was formed, explaining in detail the significance, purpose, and content of the professional learning

community for teachers, as well as the operation plan of the community in this case, in order to obtain the recognition and support of the relevant leaders and functional departments. At the same time, the head of the school's Teacher Development Center was invited to join the community, as well as experts in related research fields within the discipline of pedagogy from both inside and outside the school to serve as special guests of the community.

In terms of financial support, we actively apply for projects and obtain funding to provide basic financial support for the operation of the community.

2.3.2. Public recruitment of members. With the support of the teaching authority of the host university, the leader of the community publishes a notice throughout the university in the form of voluntary enrollment to openly recruit community members and receive applications from teachers. Based on the reasonable size of the community and taking into account the age, gender, title, and discipline of the applicants, a number of full-time teachers and professionals are identified to form the membership structure of the community, with members covering as many disciplines as possible in their university.

2.3.3. Formalization of the community. When the list of community members was determined, a QQ discussion group and a WeChat group were set up during the vacation time, in which basic information about the community, reference books and papers were shared, and individual exchanges were made with the members to solicit suggestions and opinions on community activities, on the basis of which a detailed and complete plan for the operation of the community was formed.

2.3.4. Community organization. The “supporter” function: creating a supportive community environment, providing members with the necessary resources and information, stimulating participation, eliminating negative feelings, and serving as a catalyst for academic improvement.

The “Facilitator” function: uses organizational management tools to enhance the goals of the community, creates a framework to guide the work of the community, and reviews the day-to-day responsibilities and tasks of the community.

The “motivator” function: oversees and directs the behavior of community members in their interactions, and through careful observation and constant feedback, intervenes as necessary to bring the team back to the community's overriding goals.

3. Methodology for analyzing key elements of the community-building framework

3.1. CRITIC weighting method

In order to determine the difference in importance between different indicator designs, the modified CRITIC weighting method is selected as the assignment method in this paper. Let's take a look at the traditional CRITIC weighting method before introducing the modified CRITIC weighting method. The CRITIC weighting method calculates the weights according to the comparative strength and conflict between the indicators in order to ensure the scientificity and fairness of the evaluation, and it is a scientific method superior to the entropy weighting method and the fuzzy set method in terms of weight setting. When determining the weights of the indicators, firstly, we need to pay attention to the characteristics of the data itself, including the volatility, difference and relevance of the data, where the difference is mainly measured by the standard deviation, the larger the standard deviation, the larger the difference of the samples in a certain indicator, and at this time, the weight given is also higher. Secondly, the method also needs to examine the conflict between indicators, which is mainly reflected by the correlation coefficient, the stronger the correlation, the lower the conflict, such indicators will be given a smaller weight. In general, the traditional CRTTIC weighting method has the following specific calculation steps [22]:

First, standardize the data. After acquiring and cleaning the data, it is necessary to consider whether the data are positive or negative indicators and do standardization on them. Assuming that the data set is $Z=(z_{ij})_{n\times d}$, there are a total of n samples and d indicators. For positive indicators according to equation (1) to do standardization, negative indicators according to equation (2) to do standardization:

$$y_{ij}=\frac{z_{ij}-\min(z_j)}{\max(z_j)-\min(z_j)} \tag{1}$$

$$y_{ij}=\frac{\max(z_j)-z_{ij}}{\max(z_j)-\min(z_j)} \tag{2}$$

Second, the degree of dispersion is calculated. The standard deviation is an important indicator of the degree of dispersion of the data distribution, and its size reflects the degree of deviation between the values and the mean. When the standard deviation is large, it means that the distribution of values in the data set is more dispersed, and the gap between the values of each sample point increases, so its weight will increase accordingly. The formula for calculating the standard deviation is shown in (3):

$$\begin{cases} \bar{Y}_j=\dfrac{1}{n}\sum_{i=1}^{n}Y_{ij} \\ \sigma_j=\sqrt{\dfrac{1}{n-1}\sum_{i=1}^{n}(Y_{ij}-\bar{Y}_j)^2} \end{cases} \tag{3}$$

Third, the degree of conflict of the indicators is calculated. Assumption r_{ij} is the correlation coefficient of indicators i and j, and π_{ij} represents the conflict between indicators. The relationship between the two is shown in expression (4), in which the correlation between indicators is negatively correlated with the conflict. When the correlation between the indicators is increased, the conflict between the two will be weakened accordingly, leading to an increase in the repeatability of the information conveyed by the indicator, which makes the importance of the indicator be reduced, and thus obtain a smaller weight in the weight allocation. The specific calculation formula is as follows:

$$\pi_{ij}=\sum_{i=1}^{d}(1-r_{ij}) \tag{4}$$

Fourth, calculate the composite weights. Taking into account the differences and conflicts of the indicators, a comprehensive weight can be obtained as a way to make a comprehensive assessment of the information content of each indicator. Because some studies show that the comprehensive weight corresponds to the size of the amount of information, that is, the larger the amount of information, the larger the comprehensive weight. Let η_j denote the amount of information of the j nd indicator, which is also the comprehensive weight of indicator j, and its specific expression is as follows:

$$\eta_j=\sigma_j\times\pi_j \tag{5}$$

Fifth, calculate the normalized weights. Since the sum of the weights of all indicators is equal to 1 in general, it is necessary to normalize the weights, assuming that w_j is the weight value of the j nd indicator, there are:

$$w_j=\frac{\eta_j}{\Sigma_{j=1}^{d}\eta_j} \tag{6}$$

The above introduces the traditional CRITIC weighting method, but this method has some defects, which does not take into account the positivity and negativity of the correlation coefficient or the degree of dispersion between the data of the indexes under study. Therefore, this paper slightly

improves the traditional CRITIC weight method to get the modified CRITIC weight method, i.e., when calculating the conflicting indicators, use $|r_{ij}|$ instead of r_{ij} to get:

$$\pi_{ij}^{*}=\sum_{i=1}^{d}(1-|r_{ij}|) \tag{7}$$

The discrete degree part is replaced by $\tau_j+\sigma_j$, where τ_j is the entropy value of the indicator calculated by the entropy value method, so that the weight of the indicator can be obtained as:

$$w_j^{*}=\frac{(\tau_j+\sigma_j)\times\pi_j^{*}}{\Sigma_{j=1}^{d}(\tau_j+\sigma_j)\times\pi_j^{*}} \tag{8}$$

3.2. Multiple linear regression

A regression model is a special type of mathematical regression model that determines the correlation between variables and allows for purposeful prediction of a variable. One-dimensional linear regression models are the simplest of these. However, when portraying the data and establishing the relationship between the variables, we find that the change of the dependent variable is affected by many factors, so for the sake of the comprehensiveness of the information and the accuracy of the model, we need to establish a multiple linear regression model for the data.

The specific expression is as follows:

$$y=\beta_0+\beta_1x_1+\beta_2x_2+\ldots+\beta_kx_k+\mu \tag{9}$$

where β_0 is called the constant term; $\beta_1,\beta_2,\ldots,\beta_k$ is called the regression coefficient, y is the random dependent variable, $x_1,x_2,\ldots,x_k$ is the non-random independent variable, and μ is called the random error term.

If n observations are made for y and x and n sets of observations $y_i,x_{i1},\cdots x_{ik}(i=1,2,\cdots,n)$ are obtained, then they are related as follows:

$$y_i=\beta_0+\beta_1x_{i1}+\cdots+\beta_kx_{ik}+\mu_i \tag{10}$$

Introducing matrix notation, notation:

$$y=\begin{bmatrix}y_1\\y_2\\\vdots\\y_n\end{bmatrix},X=\begin{bmatrix}1&x_{11}&\cdots&x_{1k}\\1&x_{21}&\cdots&x_{2k}\\\vdots&\vdots&&\vdots\\1&x_{n1}&\cdots&x_{nk}\end{bmatrix},\beta=\begin{bmatrix}\beta_0\\\beta_1\\\vdots\\\beta_k\end{bmatrix},\mu=\begin{bmatrix}\mu_1\\\mu_2\\\vdots\\\mu_n\end{bmatrix} \tag{11}$$

Then model (10) can be written in the following form:

$$Y=X\beta+\mu \tag{12}$$

where Y is the $n\times1$ observation vector; X is the $n\times(k+1)$ known design matrix; μ is the $n\times1$ random error term, and β is the $(k+1)\times1$ unknown parameter vector.

In regression analysis, multiple linear regression occupies a fundamental and very important position. First of all, linear regression has a promising future and is used in various fields such as education and medicine. Secondly, real-life examples are generally applicable to the establishment of linear regression models, and non-linear can also be "linearized" to reduce the complexity of the model, for example, the power function to take the logarithm, can be converted from a non-linear model to a linear one. Finally, many economic problems can be modeled with linear models, which are more realistic and can yield effective predictions. For better model parameter estimation, hypothesis testing and judgmental prediction. Typically, the construction of multiple linear regression models is often

carried out under some classical assumptions. If the model does not satisfy these classical assumptions, then it will lead to wrong analysis results and cause some troubles.

The classical assumptions of the linear regression model are as follows:

1) The random error term μ_i is a random variable with an expected value or mean of 0 that satisfies the assumption of unbiasedness:

$$E(\mu_i) = 0, (i = 1, 2, \ldots, n) \tag{13}$$

2) The random error term has the same variance for all observations of the explanatory variables, satisfying the homogeneity assumption:

$$\text{var}(\mu_i) = \sigma^2, i = 1, 2, \ldots, n \tag{14}$$

3) The random error terms are uncorrelated with each other:

$$\text{cov}(\mu_i, \mu_j) = E(\mu_i \mu_j) = \begin{cases} \sigma^2, i = j \\ 0, i \neq j \end{cases} (i, j = 1, 2, ..., n) \tag{15}$$

This condition is called Gauss-Markov condition [23].

4) The explanatory variables do not have the property of randomness and are uncorrelated with the random error term:

$$\text{cov}(x_{ij}, \mu_j) = 0, (i = 1, 2, \cdots, k, j = 1, 2, \ldots, n) \tag{16}$$

5) The explanatory variables do not have a perfect linear relationship with each other. In mathematical language, the matrix of sample observations of the explanatory variables is full rank:

$$\mu_i \sim N(0, \sigma^2) \tag{17}$$

6) The random error term obeys normal distribution to ensure the validity of F test and t test.

Under these conditions, the validity of the regression coefficients and the estimation of σ^2 can be obtained, the significance of the explanatory variables in the regression model as well as the model as a whole can be obtained, and the correct estimation of the prediction intervals can be obtained.

3.3. Indicator design

In this paper, the community development factors of virtual teaching and research community are divided into granularity indicator levels. The first-level indicators of community development of virtual teaching and research community as coarse-grained and the third-level indicators as fine-grained are divided into coarse-grained layer and fine-grained layer. There are 16 fine-grained output indicators in the fine-grained layer, and 5 coarse-grained output indicators are extracted from the fine-grained output indicators.

The coarse-grained indicators are:

University recognition Y1, including departmental support Y101 and financial support Y102.

Teaching and research team building Y2, including the number of members Y103, members' academic qualifications Y104, papers published Y105, and research awards Y106.

Teaching and research motivation Y3, including establishment of groups Y107, sharing of materials Y108, presentations and discussions Y109, and opinions and suggestions Y110.

Community guidelines implementation Y4, including task completion Y111, participation in teaching and research activities Y112, and community atmosphere creation Y113.

Organizational management structure Y5, including teaching and research planning Y114, organizational coordination Y115, and supervision and implementation Y116.

4. Analysis of results

Taking University G as an example, the virtual teaching and research community was established in accordance with the framework of virtual teaching and research community community building, and through the questionnaire survey to collect the situation of the indicators that may be important in the process of the development of the teaching and research community, and through the results of the questionnaire to sort out the fine-grained indicators and coarse-grained indicators, in order to understand the key factors that play an important role in it.

4.1. CRITIC weight solving

Prior to the use of the CRITIC method, the data for the granularity output indicators in the sample were normalized. The fine-grained normalized data are shown in Table 1 and the coarse-grained normalized data are shown in Table 2.

Table 1. Normalized data table of fine-grained indicators

Fine-grained	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	…
Y101	0.4012	0.83059	0.9389	1	0.66063	…
Y102	1	0.94612	0.85435	0.82129	0.54015	…
Y103	0.2624	0.5281	0.60811	0.42317	0.52429	…
Y104	0	0.34515	0.26291	0.23426	0.75677	…
Y105	0.36452	0.74629	1	0.66127	1	…
Y106	0.71381	0.14713	0.29063	0.12339	0.37076	…
…	…	…	…	…	…	…

Table 2. Normalized data table of coarse-grained indicators

Fine-grained	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
Y1	0	1	0.78561	0.55352	0.45689
Y2	1	0.72349	1	1	1
Y3	0.77415	0.67683	0.25313	0.68172	0.51696
Y4	0.28275	0.19785	0.29131	0.17293	0.16808
Y5	0.98907	0.72167	0.52138	0.72546	0.28592
…	…	…	…	…	…

The volatility of the indicator is obtained by equation (3), the conflict of the indicator is calculated by equation (7), and the information carrying capacity of the indicator is calculated by combining the volatility and conflict of the indicator by (5). Next, the objective weights of the indicators are obtained from (8) w_j. The weights of the community building indicators of the teaching and research community are shown in Figure 1.

As can be seen from the weights of the fine-grained indicators in Figure 1, the weights of the indicators are as follows: departmental support (Y101) 0.0888, financial support (Y102) 0.0803, number of members (Y103) 0.0574, members' academic qualifications (Y104) 0.1129, thesis publications (Y105) 0.0935, research awards (Y106) 0.0596, establishment of Groups (Y107) 0.0971, Sharing of materials (Y108) 0.0308, Presentations and discussions (Y109) 0.1203, Suggestions (Y110) 0.0202, Tasks accomplished (Y111) 0.0222, Participation in teaching and research activities (Y112) 0.0768, Creation of a community atmosphere (Y113) 0.0441, Teaching and research planning (Y114) 0.0474, organization and coordination (Y115) 0.0247, and supervision and implementation (Y116) 0.0240. The top three virtual teaching and research community community development indicators

were: speaking and discussing (Y109) 0.1203, members' academic qualifications (Y104) 0.1129, and establishment of groups (Y107) 0.0971.

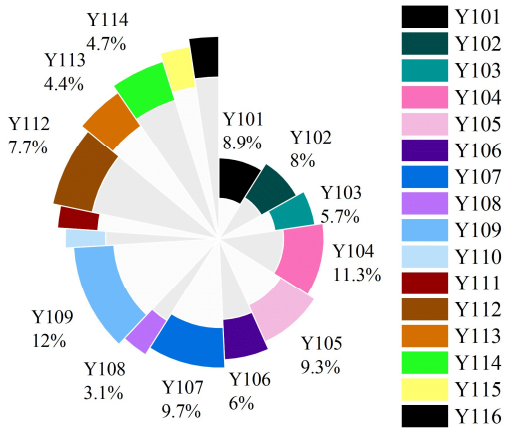

Fig. 1. Fine-grained indicator weights

The CRITIC weights of the coarse-grained indicators are shown in Figure 2. From the coarse-grained indicator weights in Figure 2, it can be seen that for the virtual teaching and research community, the above 16 fine-grained indicators can be categorized into five major categories, and the categories and corresponding CRITIC weights are: university recognition (Y1) 0.1692, teaching and research team building (Y2) 0.3234, teaching and research motivation (Y3) 0.2683, and community guideline implementation (Y4) 0.1431, Organizational management structure (Y5) 0.0961. The results of the size ranking of the coarse-grained indicators were: teaching and research team building (Y2) 0.3234 > teaching and research motivation (Y3) 0.2683 > school approval (Y1) 0.1692 > community guideline implementation (Y4) 0.1431 > organizational and management structure (Y5) 0.0961.

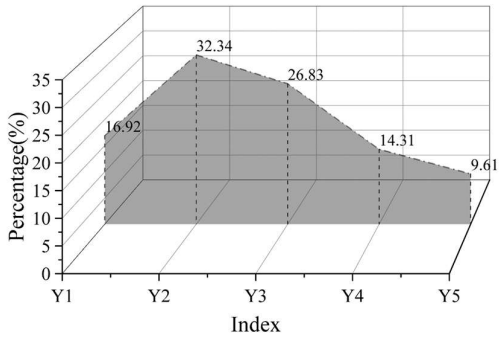

Fig. 2. Coarse-grained index weights

4.2. Multiple linear regression results

4.2.1. Research hypotheses. The 13 dimensions measured by the Teacher Professional Development Factors Scale were used, and the 2 key factors ranked high by CRITIC empowerment, i.e., Teaching and Research Team Building and Teaching and Research Motivation, were added as independent variables to analyze the impact of this factor on teachers' professional development. Therefore, the research hypotheses of this study are as follows: professional knowledge (X1), teaching skills (X2), reflective ability (X3), student guidance (X4), learning attitude (X5), research ability (X6), curriculum design and innovation (X7), information technology application (X8), teamwork (X9), professional ethics (X10), policy understanding (X11), cultural sensitivity (X12), psychological quality (X13), teaching and research team building (X14), and teaching and research motivation (X15) have a significant effect on the effectiveness of teachers' professional development. Teacher professional development was the

dependent variable, which was assessed in two parts, namely teacher professional knowledge and teacher professional skills.

4.2.2. Results of Regression Analysis of Factors Influencing Teachers' Professional Knowledge. Table 3 shows the goodness of fit of the regression equation and the significance test of covariance between the independent variables. From the table, it can be seen that the multivariate correlation coefficient R of the 15 independent variables with the effect of teachers' professional development is 0.789, the coefficient of determination R^2 is 0.623, the standard error of estimation of the mean square sum of the regression model errors is 0.34, and the Durbin-Watson test statistic is 1.937. Because this paper utilizes the forced-entry variable method, there is only one regression model, and because the coefficient of determination of this model is R2 of 0.623, which indicates that it is a good fit, the 15 independent variables can explain a total of 62.3% of the variance of the dependent variable of the "Overall Professional Development Effectiveness". From Table 3, it can also be seen that the Durbin-Watson statistic for this equation is 1.937, which indicates that the independent variables of this equation do not have serious covariance problems and can continue to be tested further.

Table 3. Fitting test of the regression model

Model summary b					
Model	R	R^2	Adjusted R^2	SE	Durbin-Watson
1	0.789	0.623	0.607	0.34	1.937

Table 4 is the ANOVA summary table of the regression model, which mainly reflects the results of the significance test of the linear relationship between all independent variables and the dependent variable. The table shows that the F-value of its linear relationship test is 52.281, and the P-value is 0, which is less than the significant level of 0.01, indicating that there is a significant linear relationship between all the independent variables and the dependent variable in the regression model, and that the independent variables can indeed influence the dependent variable.

Table 4. Significance F test of regression model

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	194.481	23.00	7.4681	52.281**	0.000
	Residual error	120.738	843.00	0.159		
	Sum.	315.219	866.00			

Table 5 shows the regression results of teachers' professional knowledge, standardized regression coefficient Beta, regression coefficient significance test T value and significance probability value, and collinearity development influencing factors, including the statistical tolerance and variance expansion coefficient (VIF) of the non-standardized regression coefficient B diagnosis, which mainly reflect whether the linear relationship between the respective variables is significant to the dependent variable, that is, whether the independent variables have a significant influence on the dependent variable.

As seen in Table 5, in the regression coefficient test of the 15 independent variables and the dependent variable, professional knowledge X1 (Beta=0.212, P=0.024<0.05), teaching skills X2 (Beta=0.111, P=0<0.01), reflective ability X3 (Beta=0.029, P=0<0.01), learning attitude X5 (Beta= 0.067, P=0.006<0.05), research ability X6 (Beta=0.136, P=0<0.01), psychological quality X13 (Beta=0.03, P=0<0.01), teaching and research team building X14 (Beta=0.18, P=0<0.01), and motivation of teaching and research X15 (Beta=0.158, P= 0.001<0.01), a total of 8 factors regression coefficients were significant.

From the tolerance and VIF values of the linear diagnostic test of the independent variables, it can be seen that the minimum value of the tolerance of all the respective variable coefficients is 0.111, thus all the tolerance values are greater than 0.1, and the maximum value of the variance inflation factor, VIF, is 7.926, thus all of its values are less than 10, which indicates that there is no serious covariance problem with all the independent variables in the regression model, and thus it also ensures that the regression results are scientifically valid.

It is also seen that the absolute magnitude of Beta among the above eight significant factors in the order of professional knowledge X1 (Beta=0.212) > Teaching and research team building X14 (Beta=0.18) > Teaching and research motivation X15 (Beta=0.158) > Research ability X6 (Beta=0.136) > Teaching skills X2 (Beta=0.111) > Learning attitude X5 (Beta=0.067) > Psychological quality X13 (Beta=0.03) > Reflective ability X3 (Beta=0.029).

As a result, it was found through regression analysis that the main factors affecting the effect of teachers' professional knowledge development were professional knowledge, teaching and research team building, teaching and research motivation, curriculum design and innovation, teaching skills, student guidance ability, psychological quality, and reflective ability, in order of the size of the impact effect, all of which were positive and significant impact effects.

Table 5. Regression result

Coefficient a (the average score of teacher's professional knowledge)							
	B	SE	Beta	t	Sig.	Colinear diagnosis	
						Tolerance	VIF
Consistent	0.259	0.054	0.031	0.638	0.265	0.669	1.267
X1	0.218	0.043	0.212	3.829	0.024	0.111	1.753
X2	0.157	0.044	0.111	5.095	0	0.220	5.457
X3	0.045	0.053	0.029	6.177	0	0.272	7.448
X4	0.135	0.068	0.104	0.565	0.198	0.730	0.924
X5	0.106	0.102	0.067	3.026	0.006	0.788	4.320
X6	0.140	0.148	0.136	4.478	0	0.504	3.164
X7	0.029	0.017	0.025	1.137	0.466	0.144	5.860
X8	0.027	0.042	0.021	0.948	0.214	0.689	4.828
X9	0.075	0.061	0.061	0.921	0.219	0.242	7.408
X10	0.089	0.155	0.079	0.294	0.458	0.187	7.926
X11	0.149	0.136	0.122	0.508	0.488	0.483	4.460
X12	-0.078	0.011	-0.074	0.509	0.146	0.174	5.559
X13	0.050	0.013	0.030	5.588	0	0.663	5.024
X14	0.189	0.187	0.180	4.733	0	0.557	3.803
X15	0.166	0.138	0.158	3.862	0.001	0.675	5.300

4.2.3. Results of regression analysis of factors influencing teachers' professional skills. Table 6 shows the regression results of the factors affecting teachers' professional skills development. Table 6 shows that in the regression coefficient test of 15 independent variables and dependent variables, a total of 9 factors were related to teachers' professional skills development. The absolute Beta magnitude of all the factors were in the following order: teaching skills X2 (Beta=0.182, P=0<0.01) > information technology application X8 (Beta=0.124, P=0.003<0.01) > curricular design and innovation X7 (Beta=0.116, P=0.034<0.01) > teaching and research team building X14 (Beta= 0.089, P=0.006<0.05)>Psychological Quality X13 (Beta=0.085, P=0.012<0.05)>Teaching and Research Motivation X15 (Beta=0.059, P=0<0.01)>Reflective Ability X3 (Beta=0.051, P=0.017<0.05), with the regression coefficients of a total of nine factors being significant.

Table 6. Regression result

Coefficient a (the average score of teacher's professional skill)						
	B	SE	Beta	t	Sig.	Colinear diagnosis

						Tolerance	VIF
Consistent	0.184	0.062	0.177	1.414	0.132	0.474	1.666
X1	0.025	0.088	0.017	2.507	0.003	0.517	6.357
X2	0.190	0.020	0.182	5.548	0	0.820	3.769
X3	0.066	0.017	0.051	3.750	0.017	0.531	2.853
X4	0.212	0.035	0.184	0.959	0.123	0.850	1.459
X5	0.036	0.208	0.021	1.869	0.129	0.747	6.193
X6	0.059	0.117	0.045	1.392	0.053	0.122	8.115
X7	0.140	0.214	0.116	5.327	0.034	0.090	5.191
X8	0.143	0.244	0.124	3.529	0.003	0.561	6.332
X9	0.013	0.055	0.008	0.075	0.108	0.434	0.992
X10	0.048	0.223	0.038	2.705	0.014	0.263	8.049
X11	0.193	0.174	0.164	1.077	0.054	0.342	8.246
X12	0.131	0.019	0.124	1.990	0.097	0.879	5.156
X13	0.111	0.073	0.085	3.247	0.012	0.052	5.675
X14	0.115	0.127	0.089	4.304	0.006	0.795	0.251
X15	0.076	0.102	0.059	3.909	0	0.212	8.694

It can be seen that, in addition to teaching skills, professional knowledge and other factors, the construction of the teaching and research team and the motivation of teaching and research in the virtual teaching and research community are also key factors affecting teachers' professional knowledge and skills, which are worth paying attention to when launching the construction of the virtual teaching and research community.

5. Conclusion

This paper utilizes the CRITIC weighting method to calculate the key factors in the operation of the virtual teaching and research community and to test the impact of the key factors on teachers' professional development. Assigning weights to 17 factors, the top three virtual teaching and research community community development indicators and their weights are: speaking and discussing 0.1203, members' education 0.1129, and establishing groups 0.0971. 5 coarse-grained indicators are extracted based on the results of the CRITIC assignments, and the two top-ranked coarse-grained indicators in terms of weight are the construction of teaching and research team (0.3234) and the motivation of teaching and research (0.2683). Multiple linear regression analysis was conducted with these two indicators as the key factors for the development of virtual community.

In the results of the regression analysis of the factors affecting teachers' professional knowledge, except for professional knowledge X1, the absolute values of Beta of Teaching and Research Team Building X14 and Teaching and Research Motivation X15 are 0.18 and 0.158, which are higher than the other factors and show statistical significance. In the results of the regression analysis of the factors affecting teachers' professional skills, the Beta values of the factors of teaching and research team building and teaching and research motivation were 0.089 ($p<0.05$) and 0.059 ($p<0.01$) respectively.

It indicates that the construction of teaching and research team and the improvement of teaching and research motivation in the virtual teaching and research community are conducive to the development of teachers' professional knowledge and skills.

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