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Empirical Study on the Influencing Factors of ICT-TPCK in Higher Vocational Teachers

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***ABSTRACT*: Teachers' information and communication technology (ICT) competences are crucial during the process of teaching. This paper explored the relationship of TPCK knowledge from a technical perspective, the way to define ICT-TPCK influencing factors and their relationship with the technological knowledge, technological pedagogical knowledge, technological content knowledge and technological pedagogical content knowledge (ICT-TPCK). A questionnaire adapted from Angeli, Valanides (2009) was validated by using factor analyses and regression analyses. The results revealed that TK, TCK and TPCK have a two-way relationship. The ICT-TPCK of higher vocational teachers was generally at a positive level and the level of influencing factors of ICT-TPCK in higher vocational teachers was also relatively high. Using path analysis showed that teacher training and self-efficacy had a direct impact on TK and TCK. School environment, teacher training and self-efficacy had a direct impact on TPCK. School environment and compatibility had an indirect impact on TK, TCK and TPCK.**

Key words: Higher vocational teachers, ICT-TPCK, Influencing factors of ICT-TPCK, Information and communication technology (ICT)

I. INTRODUCTION

With the development of information technology, information and communication technology knowledge will also affect the teacher's knowledge structure. Technological Pedagogical Content Knowledge was presented at the earliest times (Punya Mishra, Matthew Koehler[1], 2006). ICT integration teaching has a direct relationship with TPCK. The graphics or animation technology integration teaching has an indirect relationship with TPCK, but social media technology integration teaching has nothing to do with TPCK (Chuang[2], 2015). From the perspective of technology integration and transformation, it is proposed that ICT-TPCK pays more attention to teaching design methods and learners' cognitive characteristics in learning situations, criticizes TPCK's simple superposition and pays attention to the true integration (Angeli & Valanides[3], 2009), especially for higher vocational teachers. In the development of TPCK knowledge level of higher vocational teachers, there are insufficient understanding of TPCK, shortage of pedagogical theoretical knowledge, lack of information infrastructure, etc., not to mention the integration of information technology knowledge and teaching. This led this article to pose the following questions:

-To what extent is there a relationship between each element of TK, TCK and TPCK of higher vocational teachers?

-What are the "influencing factors" that will be investigated?

- How do the influencing factors play a role in the ICT-TPCK of higher vocational teachers?

II. MATERIAL AND METHODS

A. Participants

This study selected teachers from 36 higher vocational colleges in Jiangsu Province to conduct research, covering 9 cities and each higher vocational school teacher received 3-8 copies. The questionnaire combined online distribution with field distribution, with a total of 256 copies and 185 valid questionnaires. The effective rate of questionnaire collection was 72.3%. According to the key personal and contextual variability, sample distribution was summarized as:

a. The gender distribution of the whole sample was approximately 46.5% of male teachers and 53.5% of female teachers.

b. Higher vocational teachers have a higher proportion of postgraduates, accounting for 58.4% and undergraduates below 41.6%.

B. Data collection instrument

The data collection instrument used was the questionnaire, which was designed expressly for this research and contains three sections: First, through the literature review, the TPCK framework is combed and the

content of the ICT-TPCK framework is summarized from the technical perspective (see Table 1). Secondly, on the basis of previous studies, the reliability and validity of the data collection instrument are analyzed. Thirdly, the above questionnaires corresponding to ICT-TPCK of higher vocational teachers are designed.

Table 1 Specific content of ICT-TPCK knowledge in higher vocational teachers

ICT-TPCK	specific content
TPCK	Combining appropriate information technology with teaching strategies or methods to represent subject teaching content
TPK	Using information technology to present specific teaching strategies
TCK	Using information technology to characterize subject teaching content
TK	Using the appropriate information technology

When designing the questionnaire, domestic and foreign scholars have done a lot of research on measurement tools for knowledge of ICT. Schmidt [4] (2009) investigated the knowledge level of TPCK among 124 pre-service teachers. The reliability of the questionnaire reached 0.8 or above, and the scale became a highly recognized questionnaire scale. Archambault & Barnett [5] (2010) tested the TPCK knowledge of online teachers' training courses in K-12 schools in the United States. The results of the survey were clusters of three types of knowledge, PCK knowledge, technical course knowledge, information technology knowledge and the scale has good validity. Lee and Tsai [6] (2010) developed a questionnaire with a total of 30 items, mainly to investigate the relationship between Taiwan teachers' self-efficacy and teachers' TPCK knowledge under network technology. The reliability and validity of the questionnaire enable itself to be used as a tool for data collection. Angeli and Valanides (2009, 2013) conducted relevant empirical studies on ICT-TPCK.

To sum up, this study attempts to establish an ICT-TPCK questionnaire of 16 items that meets the characteristics of higher vocational teachers. Sections were evaluated on a 5-point Likert scale. According to the literature review analysis and the description of the existing scale items, the items of each sub-scale are written to truly reflect the main content. The main content of the measurement factors (see Table 2, Table 3).

Table 2 Survey of various dimensions of ICT-TPCK in higher vocational teachers

Component	Number of questions	Items	One of the examples for each items
TK	6	D1+D2+D3+D4 +D5+D6	D3: I have mastered how to use WORD processing software and process text information.
TPK	2	C6+C9	C6: I can use information technology to present abstract teaching content to help students understand.
TCK	3	C7+C8+C10	C8: I can use technology to develop appropriate assessment tools.
TPCK	5	C1+C2+C3+ C4+C5	C2: I can use information technology to invite teachers or experts to help students solve problems online.

Table 3 Survey of influencing factors of ICT-TPCK in higher vocational teachers

Component	Number of question	Items	Example
Self-efficacy	6	B1+B2+ B3+B4+ B5+B6	I don't have any difficulty when I study technical tools.
Compatiblity	4	B7+B8+ B9+B10	I use information technology without interfering with effective communication between teachers and students.
School Environment	4	B11+B1 2+B13+ B14	I am happy to share my experience with colleagues and leaders by using technology.
Teacher Training	3	B15+B1 6+B17	I have participated in information technology related training to improve the level of using information technology integration teaching.

C. *Data analyses*

The statistical analyses were done by using descriptive statistics, which were obtained by the SPSS 19.0

programme and by regression analyses.

D. *Reliability and validity test*

For the ICT-TPCK scale, the exploratory factor analysis method is first used to determine whether 16 items (factors) belong to four potential variables (TK, TPK, TCK, TPCK) and whether the load of each item is reached standard.

(1) The KMO test result is 0.890, which is above 0.8, indicating that the scale has good factor analysis appropriateness. And Bartlett's test value is 1938.716, with a significance of 0.000, reaching a significant level of 0.05, indicating that it is suitable for factor analysis.

(2) There are three factors that extract eigenvalues greater than 1, and the total variability is explained as 67.021%. If the variability is greater than 60%, the common factor can be considered to be reliable. Therefore, in this study we will retain the three common factors of this scale. From the perspective of division, TPK and TCK cluster into a factor, TPK is the teaching strategy and method related to information technology used by teachers for specific unit knowledge, and TCK is also using information technology knowledge for specific unit knowledge. There is commonality between the two, which is consistent with the Suzan study. Therefore, this study considers TPK and TCK as a common element, collectively referred to as TCK knowledge.

(3) The maximum variance method is used to rotate the initial component matrix, and the rotation axis is processed by the default Kaise normalization method. After seven iterations, the principal component matrix after the rotation axis is sorted according to the factor load (See table 4). In addition, the overall reliability coefficient α of the ICT-TPCK scale is 0.922 greater than 0.9, indicating that the reliability of the entire scale is very high, and the TK, TCK, and TPCK reliability coefficients α are 0.888, 0.868, and 0.832, respectively, both at 0.8 and Between 0.9, the three levels of reliability are high.

Table 4 Component matrix after ICT-TPCK rotation

题项变量	最大方差法直交转轴后的因素负荷量			共同性
	1	2	3	
D3	.907	.075	.198	.868
D2	.861	.297	.126	.846
D1	.856	.089	.201	.781
D4	.606	.449	.332	.679
D6	.599	.447	.035	.560
D5	.584	.548	-.051	.644
C4	.193	.696	.356	.649
C3	.143	.690	.423	.675
C2	.124	.681	.407	.645
C1	.427	.657	.111	.626
C5	.328	.631	.387	.656
C7	.137	.148	.818	.710
C10	.070	.086	.777	.615
C9	.102	.324	.739	.662
C6	.179	.269	.630	.501
C8	.173	.456	.605	.605
累计解释变异量	67.021%			
提取方法：主成分分析				

III. RESULTS

In this study, Richter five-point scale was adopted. The data items at all levels were different. In order to facilitate the analysis, finding the corresponding average of each level. The details are as follows: we found the ceiling value on TK and there is a big difference at the level of mastery; the ability of solving specific problems on TCK ranks second; the level of information technology and discipline integration on TPCK is low and higher vocational teachers have different levels. The gap is large. (See table 5)

Table 5 ICT-TPCK statistics of each dimension

Component	Average	Items	Average score per question	Standard deviation
TK	23.4270	6	3.9045	4.2473
TPCK	16.5243	5	3.3047	3.8857
TCK	17.2541	5	3.4508	3.0814

Table 6 Differences in ICT-TPCK at different ages and with different educational levels

Gender	ICT-TPCK		Academic qualifications	ICT-TPCK	
	male	*female*		*Undergraduate and below*	*Postgraduate*
Average	3.6439	3.5158	Mean difference	1.072	
P	0.148		P	0.473	
F	0.030		F	4.356	

In order to reflect the influence of different background factors on ICT-TPCK of higher vocational teachers, this study employed independent sample T test to analyze whether there was any difference in gender and academic qualifications. The result shows that:

a. Because F is equal to 0.030, P is equal to 0.148, which is greater than 0.05, so there is no significant difference in the ICT-TPCK mean scores of higher vocational teachers from different genders. (See Table 6)

b. Because P is equal to 0.473, which is greater than 0.05, did not reach a significant difference. The gap between higher vocational teachers with different academic qualifications on ICT-TPCK is not obvious. (See Table 6)

Subsequently, by using Pearson correlation analysis, the self-efficacy, compatibility, school environment, teacher training and TK, TCK, TPCK indicated a significant correlation between them. Therefore, self-efficacy, compatibility, school environment, teacher training and TK, TCK, TPCK are related.

After analysis, the regression model summary is obtained. The multivariate correlation coefficient between the four variables and TK is 0.687, and the estimated standard error of the regression model mean square error (MSE) is 3.122. Therefore, the R2 change is equal to the R2 statistic of 0.471, indicating four predictors. Co-explain the 47% variation in the TK dependent variable. Through the analysis of variance of the regression model, the F value of the variation significance test was 40.133, and the significance test P was 0.000, which was less than 0.05, indicating that the overall interpretation variation of the regression model reached a significant level.

Through the significance test of the predictor regression coefficient, the compatibility and school environment did not reach the significant level, but the two predictive variables of compatibility and school environment were related to the product moment of TK variables of 0.370（p=0.000）,0.402（p=0.000）. They all achieve significant positive correlation. Therefore, compatibility and school environment hardly explain the variation of the dependent variable TK.

The standard coefficients of self-efficacy and teacher training on TK are: 0.546, 0.175. The indirect impact on TK is compatibility and school environment.(see Fig.1) From the above analysis, it can be explained that the higher the consistency of behavioral habits and teaching concepts of higher vocational teachers when using information technology, the stronger their self-confidence in using information technology, and the higher their TK level. Leaders, colleagues' support for information technology use and school software and hardware configuration will affect the confidence of higher vocational teachers in using information technology and will also affect their application to information-based teaching and training, thus affecting their TK level.

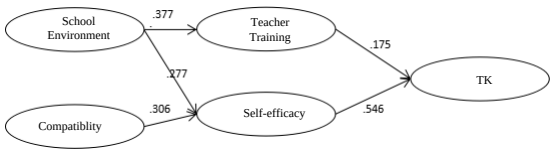

Fig.1. Path analysis of TK influencing factors

Similarly, after analysis, the regression model summary is obtained. The multivariate correlation coefficient between the four predictors and TCK is 0.654, and the estimated standard error of the regression model mean square error (MSE) is 3.122. Therefore, the R2 change is equal to the R2 statistic of 0.428. The predictors together account for 42% of the variation in the TCK dependent variable.Through the analysis of variance of the regression model, the F value of the variation significance test was 33.669, and the significance test P was 0.000, which was less than 0.05, indicating that the overall interpretation variation of the regression model reached a significant level.

The factors that have a direct impact on TCK are: self-efficacy, teacher training. The standard coefficients of

self-efficacy and teacher training on TCK are: 0.550, 0.126.(see Fig.2) From the above analysis, the higher the consistency of behavioral habits and teaching concepts in specific subject teaching when higher vocational teachers apply information-based teaching strategies or methods, the stronger their self-confidence in applying information-based teaching methods and their TCK will be higher.

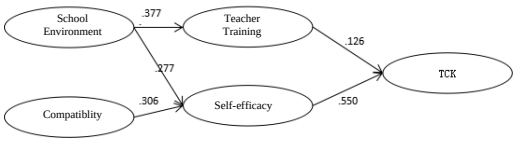

Fig.2. Path analysis of TK influencing factors

Similarly, after analysis, the regression model summary is obtained. The multivariate correlation coefficient between the four predictors and TPCK is 0.670, and the estimated standard error of the mean square error (MSE) of the regression model is 2.314. Therefore, the R2 change is equal to the R2 statistic of 0.448. The predictors together account for 44% of the TPCK dependent variable.

Through the analysis of variance of the regression model, the F value of the variation significance test was 36.580, and the significance test P was 0.000, which was less than 0.05, indicating that the overall interpretation variation of the regression model reached a significant level.

The factors directly affect TPCK are: self-efficacy, school environment, and teacher training. The standard coefficients of self-efficacy, school environment, and teacher training on TPCK are: 0.455, 0.160, 0.137. (see Fig.3)

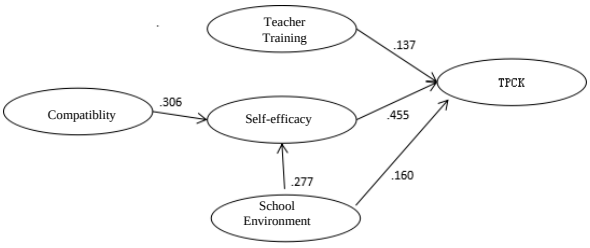

Fig.3. Path analysis of TPCK influencing factors

IV. Discussion

Through the above analysis, it can be seen that the four influencing factors of “self-efficacy”, “compatibility”, “school environment” and “teacher training” will affect the ICT-TPCK of higher vocational teachers. Mainly reflected in the following:

a. In the direct influence path, "compatibility" has no significant effect on ICT-TPCK of higher vocational teachers.

b. In the indirect influence path, "compatibility" and "school environment" will indirectly affect ICT-TPCK of higher vocational teachers.

c. There are differences in the effects of various influencing factors. Among the direct impact effects, “self-efficacy” has the greatest impact on various dimensions of ICT-TPCK of higher vocational teachers, and other factors have little impact on the effect of TPCK on higher vocational teachers. Among the indirect effects, the most important effect on TK and TCK is “school environment”. The most influential effect on total effect of TPCK is compatibility.

d. The school environment is only significantly related to TPCK . Self-efficacy, teacher training and all elements of ICT-TPCK are relevant.

V. Conclusions

A. Improve the self-efficacy of ICT-TPCK when it comes to teachers in higher vocational schools

B. Propose a training program for higher vocational teachers in terms of ICT-TPCK

From the perspective of information technology knowledge, this paper studies the influence of four influencing factors on the various elements of ICT-TPCK of higher vocational teachers, analyzes the influence of each factor, and draws relevant research conclusions. Based on the conclusions of this study, the corresponding suggestions are put forward, which lays a good foundation for the construction of the knowledge system of higher vocational teachers and also clarifies the research direction of the development of teachers' knowledge system in the future. At the same time, there are some shortcomings：it is possible to expand the selection of research subjects and involve more teachers from higher vocational colleges to participate in this research, so that the sample data volume has higher popularity and applicability; to use SPSS for further research and dig deeper to discover the inner connection between the influencing factors; to explore

deep-seated relationships; after the strategy is proposed, relevant experiments can be designed to verify its effectiveness, making the whole experimental process more scientific; to explore the measuring methods for subject teaching knowledge integrated with technology, building a method both subjective and objective, qualitative and quantitative, which would provide the foundation for the follow-up research.

REFERENCES

[1] Mishra P&Koehler M.J. Technological Pedagogical Content Knowledge: A Frame work for Teacher Knowledge [J]. Teachers College Record, 2006, 108(6): 1017-1054.

[2] Chuanga Hsueh-Hua, Wengb Chih-Yuan, Huanga Fu-Chen. A structure equation model among factors of teachers' technology integration practice and their TPCK [J]. Computers and Education, 2015.

[3] Angeli c Valanides-N.Epistemological and methodological issues for the conceptualiza-tion, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK) [J]. Computers & Education, 2009, 52(1).

[4] Schmidt D.A.-Thompson-A.D. Technological Pedagogical Content Knowledge (TPACK) : the Development and Validation of an Assessment Instrument for Preservice Teachers[J]. Journal of Research on Technology in Education, 2009, 2: 123-149.

[5] Archambault L.M. Barnett J.H. Revisiting technological pedagogical content knowledge: Exploring the TPACK framework [J]. Computers & Education, 2010, 1656-1662.

[6] Lee M.-H, Tsai C.-C. Exploring teachers' perceived self-efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web [J]. Instructional Science: An International Journal of the Learning Sciences, 38(1): 1-21.