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Exploring the Paths and Practices of Competency Enhancement of Information Technology Teachers Driven by Digital Tools

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Abstract This paper combines the questionnaire survey data to construct an evaluation system of digital teaching competence of information technology teachers that contains 5 primary indicators and 25 secondary indicators. Six male factors are extracted from it to construct the digital teaching competence influence model, and relevant hypothesis testing is carried out to find the degree of influence of each factor on teachers' digital teaching competence. Through the necessity condition test and qualitative comparative analysis, each combination of factors is mined to explain the level. Based on the quantitative calculation results, the strategies for improving digital teaching competence of IT teachers are proposed. The results showed that there were eight hypothesized P<0.001 and four hypothesized P>0.05 for the internal variables, indicating that most of the influential factors significantly affect the level of teachers' digital competence. The p-value of the difference between the path coefficients of gender and age is less than 0.001, which is significantly related to teacher competence. The overall consistency of the five grouped paths is about 0.897, the overall coverage is about 0.807, and the model has a strong ability to explain teachers' digital teaching competence.

Index Terms teaching competence, IT teachers, necessity condition test, comparative analysis, path coefficients

I. Introduction

With the rapid development of information technology, human society has fully stepped into the information age, and the wide application of information technology has profoundly changed people's way of living, working and learning [1], [2]. In the field of education, the integration of information technology has triggered a profound change, and all aspects from education concept, teaching mode to education evaluation system are experiencing unprecedented transformation [3]-[5].

The demand for talents in the information age has changed significantly, which is no longer only limited to the mastery of knowledge, but also emphasizes the comprehensive qualities such as innovative spirit, practical ability and lifelong learning ability [6], [7]. In order to cultivate talents in line with the needs of the times, education must keep pace with the times and make positive changes [8]. The traditional education model has many disadvantages such as uneven distribution of educational resources and single teaching method [9], [10]. The development of information technology, however, provides strong support and broad space for solving these problems and brings new opportunities for educational change [11]. In such a context, it is particularly important to improve teachers' IT competence [12]. As the main implementers of educational activities, teachers' information quality directly affects the quality of education [13], [14]. Teachers with good information quality can better adapt to the development trend of education informatization, deeply integrate information technology with teaching, and provide students with richer and more diverse learning experiences [15]-[17]. For example, through online courses, educational software and other tools to break the limitations of time and space, so that students can obtain knowledge anytime and anywhere [18], [19]. Use multimedia resources to visualize abstract knowledge and improve students' interest in learning and understanding [20]. With the help of data analysis tools, we can understand the learning situation of students and achieve personalized teaching to meet the learning needs of different students [21], [22]. Enhancing teachers' IT competence is also an inevitable requirement for promoting teachers' professional development. In the information age, the speed of knowledge updating is extremely fast, and teachers need to continuously learn and master new information technology and educational concepts in order to improve their teaching level and professional competence [23]-[26].

The level of digital teaching competence of information technology teachers is related to the development of students' information technology literacy. This paper starts from data collection and determines the index system related to digital teaching competence of information technology teachers based on the results of data analysis. The system common factor is extracted for testing, and the relevant model is constructed to quantitatively analyze the influencing factors and specific influencing paths of digital teaching competence of information technology teachers. Through theoretical assumptions and factor analysis, etc., verify the model fitness and whether the assumptions are valid. Further analyze the explanatory degree of the group path for the final dependent variable teachers' digital teaching competence, and propose improvement strategies.

II. Digital Competency Data Analysis for IT Teachers

In this chapter, data on indicators related to digital competency of IT teachers were collected through a questionnaire survey, from which metrics were extracted for difference detection.

II. A.Research tools

The questionnaire used in this study is the revised Digital Competency Self-Assessment Questionnaire for IT Teachers in Colleges and Universities based on the Digital Competency Self-Assessment Questionnaire for Teachers in Colleges and Universities. The questionnaire consists of a basic section and a self-assessment section. The basic part consists of control variables such as gender, work unit location, education, title and age. The self-assessment part consists of 5 level 1 indicators of IT digital technical competence, digital IT teaching competence, digital IT learning and innovation, IT digital values and pursuits, and basic personality traits, of which IT digital technical competence consists of 5 level 2 indicators of IT digital tools application, IT digital resources production, IT digital resources management, IT digital environment creation, and IT digital literacy. literacy five secondary indicators; digital IT teaching capacity by digital IT teaching design, digital IT teaching organization, digital IT guidance regulation, digital IT teaching evaluation and digital IT teaching reflection improvement of five secondary indicators; digital IT learning and innovation by digital IT professional active learning, digital IT teaching research, digital IT communication ability, digital IT critical thinking, digital IT innovation and creation of five secondary indicators; IT digital value and pursuit of IT by IT digital technology identity, IT digital ethics and morality, IT digital teaching pursuit, IT digital social service of four secondary indicators; the basic personality traits by self-confidence, self-discipline, flexibility, perseverance, cooperation and achievement motivation of six secondary indicators. The basic personality traits are composed of six secondary indicators: self-confidence, self-discipline, flexibility, perseverance, cooperation and achievement motivation. Each secondary index adopts the method of “ability + description”, which has high internal consistency and structural validity among the items and facilitates the research subjects to evaluate themselves accurately. The questionnaire was evaluated on a Likert 5.0 scale, where 1 stands for strongly disagree, 2 stands for disagree, 3 stands for unsure, 4 stands for agree, and 5 stands for strongly agree.

II. B.Project analysis

Item analysis usually adopts the critical ratio method and homogeneity test to check the reasonableness and reliability of the question items. The critical ratio method divides the items into high and low groups by 28% of the total score of the items, and then an independent sample t-test is conducted between the high and low scores to check whether there is a significant difference. The question items that did not reach significant differences had insufficient discriminatory power and needed to be deleted or reworked. The homogeneity test is to discriminate and screen individual question items by analyzing the correlation coefficient between the score of each item and the total score product difference. Table 1 shows the t-test for high and low grouping of item analysis results. The critical ratio was analyzed and reached significance at the $P=0.0001<0.001$ confidence level, so no modification was needed for each question item. The homogeneity test was conducted by Pearson correlation coefficient method, which reached significance at $P=0.0001<0.001$ confidence level, and the correlation coefficients (R) were all greater than 0.45, so each question item was retained.

II. C.Descriptive analysis of the overall level of digital competence

The overall level of digital competence of IT faculty in higher education is relatively low, but it cannot be compared directly because the weights of the level 1 indicators are not the same. For this reason a comparison is made through the number of people above the mean and the number of people below the mean. Table 2 shows the descriptive statistics of the overall level of digital competence of college IT teachers. The results show that the proportion of the number of people below the mean in the five level 1 indicators are 56.36%, 55.45%, 59.09%, 57.73% and 54.55% respectively, which are all more than 54%, which indicates that the overall level of digital competence of IT teachers in colleges and universities in Province A is low. Especially on the two items of Digital IT Learning and Creation and IT Digital Value and Pursuit, the number of people below the average value is the largest, which indicates that the college IT teachers' competence in the application, production and innovation of digital technology is seriously insufficient, and the integration of information technology and teaching activities is inadequate. The overall low level of digital competence of college IT teachers epitomizes the current reality of the level of digital competence of college teachers, which needs to be continuously improved.

Table 1: T-test for high and low groups of project analysis results

Item	Critical ratio analysis		Homogeneity correlation analysis	
	T	P	R	P
Application of digital tools in information technology	14.354	0.0001	0.816	0.0001
Information technology digital resource production	13.766	0.0001	0.897	0.0001
Information technology Digital resource management	17.147	0.0001	0.875	0.0001
Information technology digital environment creation	16.443	0.0001	0.879	0.0001
Information technology digital literacy	16.467	0.0001	0.874	0.0001
Teaching Design of Digital Information Technology	15.795	0.0001	0.907	0.0001
Teaching organization of Digital Information technology	14.896	0.0001	0.908	0.0001
Digital information technology guides and regulates	14.283	0.0001	0.913	0.0001
Teaching Evaluation of Digital Information Technology	15.874	0.0001	0.906	0.0001
Feedback on the Improvement of Digital Information Technology Teaching	15.225	0.0001	0.912	0.0001
Digital Information Technology major is actively studied	19.001	0.0001	0.916	0.0001
Teaching and Research on Digital Information Technology	18.227	0.0001	0.918	0.0001
Digital information technology communication skills	17.835	0.0001	0.876	0.0001
Critical thinking in Digital information technology	17.107	0.0001	0.927	0.0001
Innovation and creation in digital information technology	17.709	0.0001	0.915	0.0001
Recognition of information technology and digital technology	16.986	0.0001	0.829	0.0001
Digital ethics and morality in information technology	17.709	0.0001	0.877	0.0001
Pursuit of Digital information technology teaching	16.987	0.0001	0.899	0.0001
Digital information technology social services	20.490	0.0001	0.860	0.0001
Confidence	19.656	0.0001	0.884	0.0001
Self-discipline	19.670	0.0001	0.876	0.0001
Flexible	18.874	0.0001	0.887	0.0001
Perseverance	20.181	0.0001	0.841	0.0001
Cooperation	19.357	0.0001	0.887	0.0001
Achievement motivation	18.390	0.0001	0.863	0.0001

Table 2: Descriptive statistics of the overall level of digital competence(N=220)

First-level indicator	Higher than the mean (N1)	Below the mean (N2)	Mean value (M)	Standard Deviation (SD)
Information technology and digital technology capabilities	96(43.64%)	124(56.36%)	4.2159	0.8870
Teaching ability of Digital Information technology	98(44.55%)	122(55.45%)	4.2425	0.8465
Learning and creation of Digital Information technology	90(40.91%)	130(59.09%)	4.2004	0.8286
Digital Value and Pursuit of Information Technology	93(42.27%)	127(57.73%)	4.1847	0.8377
Basic personality traits	100(45.45%)	120(54.55%)	4.2885	0.7861

II. D.Factor Extraction and Difference Detection

From the obtained data related to the indicators, six metrics affecting digital competency of university IT teachers were extracted, which were personal characteristics (TCE), technology self-efficacy (TUI), perceived usefulness (PU), perceived ease of use (PEU), sustained intention to use digital technology (DC), and external factors. Among them, the external factors mainly include the influencing variables of Trainee Training (TT) and Competency Atmosphere (CA). In order to clarify the influence of demographic variables on the 6 factors, independent samples t-test was used to explore the differences in digital competence among IT teachers of different genders, one-way ANOVA was used to test the 6 factors in terms of their F-values for teachers of different ages, qualifications, titles, years of teaching experience, and school attributes, and post hoc analyses (posthoc) were used to compare the differences between groups.

Table 3 shows the results of the t-test on the 6 factors on gender. The independent samples t-test showed that the p-values of male and female IT teachers on the 6 factors were 0.001, 0.004, 0.006, 0.002, 0.004, 0.002, respectively, which were less than 0.05, and there was a significant difference, i.e., there was a gender difference in digital competence of IT teachers in colleges and universities.

Combined with the variance chi-square test, it was found that education, teaching age, and school attributes were not varied on the digital competency indicators, and further testing of variance using the Tamheeni test is needed. Table 4 shows the F-value test of the 6 factors on age, education, title, teaching age, and school attributes. The results showed that there were significant differences in the two indicators of "perceived usefulness" (P=0.041<0.05) and "continuous intention to use digital technology" (P=0.034<0.05), while the P values of all other demographic variables and numerical competency indicators were greater than 0.05, that is, there was no difference.

Table 3: The T-test of the 6 factors on gender

Variable name	Gender	Average value	Standard deviation	T value	Sig. (double tail)
Personal characteristics	Male	2.565	1.306	-0.304	0.001
	Female	2.645	1.040		
Technical self-efficacy	Male	2.266	1.066	-0.807	0.004
	Female	2.454	0.913		
Perceived usefulness	Male	2.511	1.275	0.122	0.006
	Female	2.474	0.829		
Perceived usability	Male	2.410	1.147	0.125	0.002
	Female	2.385	0.995		
Continuous intention to use digital technology	Male	2.616	1.307	0.590	0.004
	Female	2.434	0.895		
External factors	Male	2.616	1.307	0.541	0.002
	Female	2.434	0.895		

Table 4: The F-value test of 6 factors on different attributes

Variable name	Age		Educational background		Title		Teaching experience		School attributes	
	F	P	F	P	F	P	F	P	F	P
Personal characteristics	1.135	0.336	0.722	0.541	2.013	0.114	1.516	0.176	1.001	0.426
Technical self-efficacy	0.107	0.957	1.035	0.383	1.135	0.335	0.611	0.714	1.566	0.173
Perceived usefulness	0.855	0.468	0.607	0.615	2.693	0.041	1.057	0.391	1.674	0.145
Perceived usability	0.503	0.675	2.061	0.108	1.516	0.213	1.065	0.385	0.576	0.714
Continuous intention to use digital technology	1.551	0.204	0.454	0.715	2.498	0.034	1.562	0.162	0.694	0.706
External factors	1.532	0.305	0.554	0.416	2.594	0.231	1.554	0.365	0.532	0.501

III. Digital Competency Modeling and Path Mining for IT Teachers

Combining the extracted public factors and rational behavior theory, etc., the relevant hypotheses of competency influencing factors are proposed and hypothesis testing is carried out. Mining the combination path of each factor's influence on competency, providing data support for the subsequent proposal of competency enhancement strategies.

III. A. Modeling

III. A. 1) Theoretical assumptions

1) Continuous digital technology use intention and technology self-efficacy

A model based on the Theory of Acts of Reason (TAM) is constructed for the factors affecting digital competence of college IT teachers. In TAM, the actual technology use behavior is the final dependent variable, so this study intends to refer to this idea to adopt the level of digital competence of college IT teachers instead of the actual technology use behavior as the final dependent variable. Considering that changes in the level of digital competence need to go through a period of time before they become visible, this study adopts continuous intention to use digital technology instead of intention to use behavior in TAM. When teachers' intention to use digital technology tools is stronger, they are more likely to utilize digital tools in their teaching to improve the efficiency of teaching and learning, and their digital teaching competence will be improved accordingly. Technology self-efficacy refers to the degree of teachers' confidence in their ability to use digital technology tools in their teaching work to improve their professionalism and students' learning efficiency. Generally speaking, when teachers' self-confidence is higher, they are more willing to use digital teaching technology in their teaching and the level of digital competence is higher. Accordingly, this study proposes the following hypotheses:

H1a: Sustained intention to use digital technology has a significant positive effect on digital competence of university IT teachers;

H2a: Technology self-efficacy has a significant positive effect on sustained digital technology use intention;

H2b: Technology self-efficacy has a significant positive effect on the level of digital competence of university IT teachers.

2) Perceived usefulness and perceived ease of use

TAM proposes that perceived usefulness (PU) and perceived ease of use (PEU) are the two main determinants of the model. In the TAM model, PEU positively influences PU, i.e., a technology with high ease of use enhances the behavioral individual's willingness, confidence, and satisfaction to use it, which reduces the distress and barriers in the process of using it, and thus enhances the behavioral individual's perceived usefulness of the technology. This study defines perceived usefulness as the extent to which college IT teachers believe that digital teaching and learning can help them improve their job performance. In specific teaching contexts, the actual role of digital technology in supporting the teaching and learning process often determines teachers' willingness to use digital technology, and teachers are more inclined to learn and continue to use the technology if its use enhances the efficiency of teaching and learning. Perceived ease of use refers to the degree to which university IT teachers perceive it to be easy to carry out digital teaching and learning, or the degree to which the use of a particular technology reduces the amount of effort expended. When teachers perceive digital technology to be helpful for their own teaching and its ease of use, then teachers are more inclined to use the technology in their teaching. Conversely, even if the new technology can greatly improve the efficiency and effectiveness of teaching and learning, but it takes a lot of time and effort to learn the technology and is difficult to learn to master, then teachers are likely to be subjectively inclined to use the technology in their teaching without necessity. Accordingly, this study proposes the following hypothesis:

H3a: Perceived ease of use has a significant positive effect on perceived usefulness;

H3b: Perceived ease of use has a significant positive effect on continued intention to use digital technology;

H3c: Perceived usefulness has a significant positive effect on sustained digital technology use intention.

3) Competency Climate and Study Training

In this study, competency climate refers to the digital technology environment in the teachers' geographic area and school, including the availability of information technology infrastructure, the degree of recognition of digital teaching by colleagues, the degree of acceptance of digital teaching by students, and the degree of convenience for teachers to use digital technology and apply it to teaching. When the competency climate is good, teachers will develop positive attitudes toward digital teaching and learning. On the contrary, when the school's digital teaching infrastructure is inadequate and the school lacks the concept of digital teaching, teachers' awareness of digital teaching will tend to be weak, and their perception of the usefulness and ease of use of the technology will become insufficient to have a sustained motivation to insist on the use of digital technology in teaching. Research and training refers to teachers receiving professional training and workshops on digital teaching skills. After the training, teachers tend to have a deeper understanding of digital competence and tend to use digital technology in their teaching to improve the quality and efficiency of their own teaching. Based on the above discussion, this study proposes the following hypotheses:

H4a: Competency climate has a significant positive effect on perceived ease of use;

H4b: Competency climate has a significant positive effect on perceived usefulness;

H4c: Competency climate has a significant positive effect on digital competency level of IT teachers in universities;

H5a: Seminar training has a significant positive effect on perceived ease of use;

H5b: Seminar training has a significant positive effect on perceived usefulness;

H5c: Seminar training has a significant positive effect on the level of digital competence of college IT teachers.

4) Hypothesis of moderating role of personal characteristics

Personal factors such as gender and age have a moderating effect on TAM. In terms of general cognition, gender, different genders have different attitudes and acceptance of digital technology use. In terms of age, younger teachers will be more accepting of technology than older teachers. Therefore this study proposes the following hypotheses:

H6a: Gender moderates the relationship between perceived usefulness and continued intention to use digital technology;

H6b: Gender has a moderating effect on the relationship between perceived ease of use and continued intention to use digital technology;

H6c: Age has a moderating effect on the relationship between perceived ease of use and ongoing digital technology use intention.

III. A. 2) Validation factor analysis

In this study, AMOS 26.0 software was used to conduct a validation factor analysis of seven variables in the hypothesized model (two variables including external factors, “training” and “competency climate”) to test whether the research hypotheses were valid. Table 5 shows the results of the model's goodness-of-fit. CMIN/df (3.583), RMSEA (0.071) RMR (0.068) and CFI (0.843) fit well and the rest of the metrics (IFI: 0.984; TLI: 0.975) were excellent, indicating good model fit.

Table 5: Model fitting degree index

Model fitting coefficient	Reference standard	Measured result	Fitting situation
CMIN/df	1-3.5:excellent;3.5-5:good	3.583	Good
RMSEA	<0.05:excellent;<0.09:good	0.071	Good
RMR	<0.05:excellent;<0.09:good	0.068	Good
IFI	>0.95:excellent;>0.85:good	0.984	Excellent
TLI	>0.95:excellent;>0.85:good	0.975	Excellent
CFI	>0.95:excellent;>0.85:good	0.843	Good

III. A. 3) Research hypothesis testing

Based on the above premise of good model fit, the hypotheses of this study were tested for validity. Table 6 shows the results of the specific structural equation modeling tests. It can be seen that the S.E values for each path are greater than 0.000, with significance $p<0.001$ for H1a, H2a, H2b, H3a, H3b, H3c, H4a, and H5a; and significance $p=0.083$, 0.376, 0.725, and 0.311, which are greater than 0.005, i.e., non-significant, for H4b, H4c, H5b, and H5c. This shows that the hypotheses H1a, H2a, H2b, H3a, H3b, H3c, H4a and H5a of this study are valid and the hypotheses H4b, H4c, H5b and H5c are not valid.

From H1a, H3b, H4a and H5a, CA had a significant effect on PEU ($\beta=0.475$, $p<0.001$), TT had a significant effect on PEU ($\beta=0.361$, $p<0.001$), PEU had a significant effect on TUI ($\beta=0.536$, $p<0.001$), and TUI had a significant effect towards DC ($\beta=0.485$, $p< 0.001$), suggesting that good CA and TT can make teachers perceive digital technology as helpful and easy to use in their own teaching, which in turn makes them more willing to use digital technology in their teaching on a consistent basis. From H3a and H3c, PEU has a significant effect on PU ($\beta=0.550$, $p<0.001$) and PU has a significant effect on TUI ($\beta=0.184$, $p<0.001$), which is a strong evidence that teachers who perceive that digital technology is easier to use will consider digital technology to be more useful for their own teaching, and thus will use the technology in their teaching consistently; from H2a and H2b there is a significant effect of TCE on TUI ($\beta=0.321$, $p<0.001$) and TCE on DC ($\beta=0.246$, $p<0.001$), suggesting that teachers are more willing to use digital instructional technology in their teaching when they have a higher level of confidence in using digital technology in their teaching. However, from H4b, H4c, H5b and H5c, CA and TT could not directly increase the level of teachers' digital competence, which was mainly influenced through mediating variables such as perceived ease of use and continued intention to use digital technology.

Table 7 shows the results of structural equation modeling multi-cluster analysis. For the moderating variables, this study used structural equation modeling multi-cluster analysis, the p-value of the difference between the path coefficients of gender and age in the relationship between PEU, PU and TUI is less than 0.001, which shows that gender and age have a significant moderating effect in the relationship between PEU, PU and TUI, and the H6a (gender has a moderating effect on the relationship between PU and TUI), H6b (gender has a moderating effect on the relationship between relationship between PEU and TUI), H6b (gender has a moderating effect on the relationship between PEU and TUI) and H6c (age has a moderating effect on the relationship between PEU and TUI) hypotheses are valid. Specifically, female teachers were significantly higher on the effect of PEU on TUI ($\beta=0.580$) than male teachers ($\beta=0.455$); and female teachers were significantly higher on the effect of PU on TUI ($\beta=0.455$) than male teachers ($\beta=0.324$).

Table 6: Model parameter test values and research hypothesis verification

Hypothesis	Model path	Path coefficient (β)	S.E.	C.R.	P	Research hypothesis
H1a	TUI-DC	0.485	0.045	10.031	***	Establish
H2a	TCE-TUI	0.321	0.037	8.977	***	Establish
H2b	TCE-DC	0.246	0.044	5.160	***	Establish
H3a	PEU-PU	0.550	0.065	7.202	***	Establish
H3b	PEU-TUI	0.536	0.047	10.611	***	Establish
H3c	PU-TUI	0.184	0.043	4.514	***	Establish
H4a	CA-PEU	0.475	0.071	6.797	***	Establish
H4b	CA-PU	0.147	0.075	1.724	0.083	Disestablish
H4c	CA-DC	0.055	0.061	0.881	0.376	Disestablish
H5a	TT-PEU	0.361	0.075	5.114	***	Establish
H5b	TT-PU	0.027	0.070	0.346	0.725	Disestablish
H5c	TT-DC	0.060	0.053	1.010	0.311	Disestablish

Note: *** indicates P<0.001.

Table 7: Multi-group analysis of structural equation models

		Estimate	S.E.	C.R.	P
Male	Usage intention<--Perceived ease of use	0.455	0.045	9.853	***
	Usage intention<--Perceived usefulness	0.324	0.037	8.404	***
Female	Usage intention<--Perceived ease of use	0.580	0.056	10.231	***
	Usage intention<--Perceived usefulness	0.455	0.048	9.244	***
30-40	Usage intention<--Perceived ease of use	0.582	0.091	6.240	***
	Usage intention<--Perceived usefulness	0.417	0.073	5.592	***
Over 55	Usage intention<--Perceived ease of use	0.515	0.055	9.211	***
	Usage intention<--Perceived usefulness	0.332	0.047	6.790	***
41-54	Usage intention <-- Perceived ease of use	0.531	0.060	8.741	***
	Usage intention<--Perceived usefulness	0.368	0.046	7.774	***
20-39	Usage intention<--Perceived ease of use	0.289	0.127	2.221	***
	Usage intention<--Perceived usefulness	0.437	0.202	2.173	***

Table 8 shows the results of the standardized Bootstrap mediating effect test. In this study, Hayes's Bootstrap test was used to test the mediating effect of PEU, PU, and TUI on the basis of 6000 repeated samples ①. In this study, PEU, PU and TUI were used as mediating variables, resulting in a total of eight paths. The confidence intervals of the mediating paths ①-⑧ at the 95% confidence level Bias-corrected method are all greater than 0, which can indicate that the point estimates of the mediating effects are significant. Combined with the above analysis, in the mediating paths ①-④, CA and TT cannot directly affect the level of teachers' digital competence, so PEU, PU and TUI can play a full mediating effect; in the mediating path ⑧, TUI plays a partial mediating role.

Table 8: Standardized Bootstrap mediation effect test

Path	Indirect effect coefficient	Examined on both sides of P-value	95% confidence interval		Mediating effect
			Lower bound	Upper bound	
①CA→PEU→PU→TUI→DC	0.027	0.005	0.005	0.060	Support
②CA→PEU→TUI→DC	0.138	0.003	0.050	0.270	Support
③TT→PEU→TUI→DC	0.017	0.004	0.002	0.046	Support
④TT→PEU→PU→TUI→DC	0.099	0.002	0.022	0.212	Support
⑤PEU→PU→TUI→DC	0.051	0.003	0.014	0.095	Support
⑥6PEU→TUI→DC	0.276	0.002	0.150	0.427	Support
⑦OPU→TUI→DC	0.099	0.005	0.021	0.155	Support
⑧TCE→TUI→DC	0.160	0.003	0.087	0.266	Support

III. B. Configuration path analysis

III. B. 1) Necessity condition test

According to the fsQCA method, the necessity of individual condition variables needs to be analyzed before grouping fuzzy sets, and Table 9 shows the results of necessity analysis of all individual antecedent variables. Consistency indicator (Consistency) and Coverage indicator (Coverage) are usually used to judge. In Table 9, the Consistency indicator Consistency has a maximum value of 0.761904, which is less than 0.8, then it is considered that the antecedent condition X does not constitute a necessary condition for the outcome variable Y (digital competency level of IT teachers); the Coverage indicator (Coverage) has a value of more than 0.7 in all cases, which indicates that the antecedent condition X has a stronger explanatory power for the outcome variable Y in all cases.

Table 9: Necessity analysis of a single antecedent variable

Outcome variable:Digital competency level		
Antecedent variable	Consistency	Coverage
TCE	0.619049	0.928570
TUI	0.476195	0.725001
PU	0.333336	0.823527
PEU	0.761904	0.744185
DC	0.500001	0.913044
TT	0.642858	0.729735
CA	0.309526	0.900304

III. B. 2) Results of qualitative comparative analysis

The results of fsQCA analysis by the software yielded three types of solutions: complex, parsimonious and intermediate solutions. According to the rules of qualitative comparative analysis of QCA, if a certain antecedent condition appears in both the simple solution and the intermediate solution at the same time, then this condition is the core antecedent condition, which has an important influence on the result variable; if the antecedent condition only appears in the intermediate solution, then this antecedent condition is the marginal condition, which plays an auxiliary role in the result variable. From the results of fsQCA software, it can be found that "technical self-efficacy (TUI)" and "competency atmosphere (CA)" both appear in the simple solution and intermediate solution, indicating that these two antecedents are the core components and play an important role in the performance of digital teaching competency of college IT teachers.

Table 10 shows the specific results of the fsQCA qualitative analysis of digital teaching competence of IT teachers. Note: "●" and "⊗" indicate the presence or absence of the core causal condition, respectively, "●" and "⊗" indicate the presence or absence of the auxiliary causal condition, respectively, and blank indicates that the presence or absence of the condition has no effect on the results. There are five grouping paths in Table 10. The consistency of each group state is greater than 0.95, the overall consistency (Consistency) is about 0.897, and the overall coverage (Coverage) is about 0.807, indicating that the combination of antecedent conditions obtained from the qualitative analysis has a strong explanation of the outcome variables, and that the conditions that play a role in the digital teaching competence of IT teachers in colleges and universities can be understood in accordance with the corresponding group state paths.

IV. Strategies for Improving IT Teacher Competency

IT teacher digital teaching competency is a way for teachers to continuously enhance their skills and improve their quality in the digital tool-driven smart education environment, so that they can be better equipped for the educational work of cultivating the comprehensive and personalized development of digital native generation learners. This is a necessary way to realize smart education and promote educational integration and innovation, and also an important way to improve teachers' digital competence, enhance the quality of IT teaching, and cultivate high-quality talents. Therefore, this paper combines the results of the above research to make the following suggestions on how to improve the development of digital teaching competence of information technology teachers:

1) Recognize the direction of discipline development and promote the training of digital teaching competence for IT teachers. With the continuous development of intelligent technology, the future of human-computer coexistence will be a reality that students of the digital native generation must face, and in this regard, it is necessary to "improve the ability of teachers' teaching diagnosis and accurate teaching and research driven by digital tools". In order to improve teachers' competence in accurate teaching, teacher training and research is a proven method. A comprehensive training model combining online and offline, cooperation between expert teachers, and both virtual

and real teaching has been constructed, which has an important impact on the professionalization and specialized development of teachers. At the same time, creating a good atmosphere of competence through research and training can also mobilize all kinds of teachers to continuously and consciously improve their digital competence level. In addition, training for individual differences in teachers can better meet the actual needs of teacher development. In this regard, we can establish electronic files of teachers, through data mining, learning analysis, big data and other technologies to clarify the individual differences of different teachers, provide data reference for the professional growth of teachers, so as to formulate targeted training programs for teachers and carry out accurate education and training.

Table 10: Digital Teaching Competency Combination Path

	Digital teaching competence			
Antecedent variable	Configuration I	Configuration II	Configuration III	Configuration IV
TCE		⊗	⊗	⊗
TUI	●	●	⊗	⊗
PU	⊗	⊗		⊗
PEU	⊗	⊗	⊗	
DC	⊗	⊗		
TT		⊗	⊗	⊗
CA			●	●
Raw Coverage	0.333334	0.285713	0.166665	0.142853
Unique Coverage	0.119049	0.071429	0.071426	0.047616
Consistency	1	1	0.971	1
Overall solution coverage	0.807420			
Consistency of the overall plan	0.896733			

2) Construct a teaching evaluation system and formulate standards and systems for teachers' precise teaching competency. Construct forward-looking, scientific and operable teacher teaching evaluation standards, evaluation systems and related assessment systems for future smart education. Carry out assessment at all stages of teacher training, provide reference for teachers' entry, assessment, training and title promotion, help teachers formulate career growth planning programs, and guide and promote the development and enhancement of teachers' digital teaching competency. The direction of assessment and evaluation promotes teachers to continuously enhance their intention to use digital technology and perceive its usefulness and ease of use.

3) Improve the support service mechanism and build a smart learning environment for effective implementation of digital teaching. Mobilize resources and strengths of all parties to provide teachers with support for digital teaching, such as: timely updating of infrastructure construction, basic equipment and resource allocation for smart education, building and supervising a “multi-level” education data platform with perfect functions, strengthening the interconnection and integration of big data in education; carrying out all-around smart and data-oriented campus construction, and building a smart and data-oriented campus according to the number of students, teaching and learning. To build a smart, data-enabled campus in all aspects, equipped with a reasonable number of appropriately configured computers, tablet PCs, interactive all-in-one computers and other commonly used media equipment according to the number of students and the needs of teaching, and set up appropriate IT classrooms and teaching laboratories that can meet the needs of teaching in each module. Utilizing digital tools to drive teachers to continuously improve their teaching competence.

V. Conclusion

This paper constructs a digital teaching competency model for information technology teachers, explores the competency influencing factors, and explores the path and methods to enhance their competency. From the results of hypothesis testing, it can be seen that $p<0.001$ for 8 hypotheses and $p>0.05$ for 4 hypotheses, the selected male factors have actual influence on digital teaching competence of information technology teachers. Gender and age were significantly related in 3 of the factors with p-value of difference in path coefficients less than 0.001. Combined with the results of the group path analysis, the consistency of the five group paths is greater than 0.95, the overall consistency is about 0.897, and the overall coverage is about 0.807, and the model has strong explanatory ability of digital teaching competence. In the future, under the guidance of competency enhancement strategy, the relevant index factors can be further adjusted and optimized to find the influencing factors with the greatest impact, so as to realize the effective cycle of positive enhancement.

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