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The internal logic and practical path of digital technology resources empowering teaching practice of local university teachers

Li Chunjiang[1], PhD, Professor, President
Zhao Mengfei[2], graduate student
Yu Haiying*[3], Doctor of Education, Professor, Dean of the College of Educational Sciences
Mudanjiang Normal University, Mudanjiang (China)

***E-mail:** 0701008@mdjnu.edu.cn

[1]ORCID: https://orcid.org/0009-0004-2589-4327
[2]ORCID: https://orcid.org/0009-0009-9564-862X
[3]ORCID: https://orcid.org/0000-0003-0157-4631

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Abstract: Driven by artificial intelligence and the digital transformation of education, the path of digital technology resources empowering teachers' teaching practice in local universities has become a matter of concern. This research was based on the research of teachers in three local universities in Heilongjiang Province, China. The study found that digital technology resources, teachers' digital knowledge skills and professional development activities form a collaborative mechanism of empowering teaching practice, and all three have a significant synergistic role in promoting the teaching practice of teachers in local universities. The intelligent analysing tool is the core driving force of digital technology resources empowering teaching practice, and its data-driven learning diagnosis and teaching feedback functions become the key to teaching practice. Teachers' digital knowledge and skills and professional development activities have a significant intermediary effect, showing a hierarchical and progressive path of empowering teaching practice. Therefore, in order to promote the effectiveness of local universities' digital technology resources empowering teachers' teaching practice, we should build a support system of digital technology empowering teachers' teaching practice, implement the hierarchical guidance of teachers' digital knowledge and skills empowering teaching practice, and innovate the organization mode of teachers' professional development activities empowering teaching practice.

Keywords: local universities; digital technology resources; digital literacy skills; professional development activities; teaching practice.

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INTRODUCTION

The reasons for this research

Driven by the artificial intelligence technology revolution and the digital transformation of education, China has successively issued the China Education Modernization 2035 and Outline of the Plan for Building China into a Strong Country in Education (2024–2035), clearly proposing a strategic path to lead educational development through educational digitalization. As the main force to serve the regional economic and social development, the high-quality development of local universities is not only related to educational equity and innovative talent cultivation, but also a key link in realizing the goal of a strong education nation. Teachers' digital literacy, as the core element of education digitalization strategy, not only determines the practical effectiveness of intelligent technology-enabled education and teaching, but also constitutes an important breakthrough in cracking the bottleneck of local universities' resources and enhancing the high-quality development of local universities.

This study is based on the deep integration of digital intelligence technology and education, focusing on how to analyse the path of digital technology resources empowering university teachers' teaching practice through quantitative modelling, and exploring the transmission relationship between digital technology resources, digital knowledge and skills, and professional development in the process of empowering the teaching practice; providing decision-making basis for the formulation of layered and classified local universities teacher development policies and optimizing the digital training of local universities, so as to promote local universities to better use digital intelligence technology for high-quality characteristic development.

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Literature review and research hypotheses

Digital technology resources are adapted to teaching practice. The allocation efficiency of instructional technology equipment directly affects the effectiveness of teachers' digital practices. The accessibility and perceived usefulness of digital resources significantly influence teachers' technology adoption behaviour. The appropriate digital resources can provide more possibilities and opportunities for teachers' teaching practice [1]. However, if digital resources do not match teachers 'teaching practices, it will affect the cultivation of teachers' information-based teaching ability [2]. Especially in the process of applying digital resources to teaching practice, the quality and reliability of digital resources cannot be ignored, appropriate digital resources can promote the improvement of teachers' teaching practice efficiency [3]. In order to solve the problems of systematic insufficiency and lack of precision of digital resources in teachers' teaching practice and professional development [4], and improve the configuration efficiency of digital technology equipment, that is, enhance the adaptability of digital resources and teaching practice, has become a requirement for the high-quality development of contemporary education [5]. There is a lack of planning in the construction of digital teaching resources, and the supply of digital resources is insufficient to meet the real needs of teaching [6]. Insufficient investment in digital resources in schools limits teachers' behaviour of applying digital resources in the classroom [7], resulting in students not being able to fully develop learning skills that are compatible with the technological advances of the new era [8]. Digital technology resources are not the more the better, too much information resources will make students confused and weaken the effectiveness of classroom teaching practice [9]. The usefulness of resources depends on the instructional design rather than the technology itself. Teachers should choose and use digital resources that are appropriate for their work in digital teaching practice [10]. Teachers can turn abstract teaching content into audible, tangible, recordable, and speakable teaching practices through the use of digital resources to enhance students' interest [11], and the teaching practice of selecting and using digital resources that are more relevant to the implementation of classroom teaching [12].

Teachers' digital knowledge skills, professional development, and teaching practice effectiveness. The availability of digital technology resources significantly affects the path of teachers' acquisition of digital knowledge skills [13]. Teachers need to practice the interaction of technology tools, pedagogies, and subject matter content in order to realize effective technology integration [14]. Teacher professional development activities are a key bridge between digital technology resources and teaching practices [15]. Situational professional development activities can accelerate the improvement of teachers' digital technology application capabilities. The interaction between digital technology resources and professional development can produce pedagogical efficiency gains. The level of teachers' digital knowledge skills is directly related to the reality of the effect of digital-enabled education and teaching practices [16]. With the rapid development of digital technology, digital knowledge skills are gradually becoming an important indispensable quality for college teachers to carry out teaching practice activities [17]. The professional development of innovative activities based on digital knowledge skills can promote the improvement of interdisciplinary thinking and the optimization of teaching mode and process of college teachers [18]. All learning towards transfer must go through the process of practice, and digital applications emphasize the combination of digital knowledge skills and educational teaching practices in real situations [19]. Therefore, digital knowledge skills, professional development activities and teaching practice are closely integrated to test and improve teachers' digital literacy through practical applications [20].

The current process of acquiring teachers' digital knowledge skills pays less attention to how to integrate digital knowledge skills with subject teaching and the new teaching operation path in the context of digital intelligence [21]. The application of teachers' digital knowledge skills to teaching practice is a personalized and sustainable creative activity, in which teachers combine their own digital knowledge skills with the actual practice of teaching, adopt a teaching method that meets the field of teaching practice, and continue to evolve in their professional development activities and application of teaching practice [22]. Teachers can only ensure the effectiveness of teaching practice by truly mastering digital knowledge skills and continuously strengthening them in professional development activities [23]. Teachers' digital literacy skills and professional development activities are ultimately designed to achieve the goal of empowering students through digital teaching practices. Teachers' digital literacy skills are the cornerstone of their teaching practice, and professional development activities are the bridge for integrating digital literacy skills into teaching content [24].

Based on the above analysis, the following hypotheses are proposed:

1. Digital technology resources have a positive impact on teaching practice in universities, and there are differences in the influence of different digital technology resources variables.

2. Digital knowledge and skills, professional development activities play a positive intermediary effect in the process of digital technology resources affecting teaching practice, and there are differences in the influence of different digital knowledge and skills, professional development activities variables.

RESEARCH DESIGN

Data sources

In this study, teachers of three local universities in Heilongjiang Province were sampled as survey respondents. Teachers from local universities with different school-running conditions (good, relatively good, general) were

selected as subjects, and 140 questionnaires were distributed to each school, with a total of 420 teachers participating in the survey. 398 valid questionnaires were collected by using Questionnaire Star, and the validity rate was 94.76 %. Among them, males comprise 118 individuals (29.6 %), while females account for 280 (70.4 %). In terms of age distribution, 50 participants (12.6 %) are aged 20–30 years, 108 (27.1 %) are 31–40 years old, 183 (46 %) fall into the 41–50 age bracket, and 57 (14.3 %) are aged 51–60. Regarding professional titles, assistant professors number 62 (15.6 %), lecturers 157 (39.4 %), associate professors 131 (32.9 %), and full professors 48 (12.1 %). Educational backgrounds show that 40 individuals (10.1 %) hold bachelor's degrees, 281 (70.6 %) have master's degrees, and 77 (19.3 %) possess doctoral degrees. By academic discipline, humanities fields are represented by 259 participants (65.1 %), whereas science and technology account for 139 (34.9 %). In terms of marital status, the majority, 331 individuals (83.2 %) are married, with 67 (16.8 %) reporting as unmarried.

Questionnaire design and quality

The questionnaire was compiled with 35 items extracted from China's Teacher Digital Literacy[1] educational standards. The first part is the independent variable, with 6 items on the availability of digital technology resources. The second part is the mediating variable, including 4 items on teachers' digital knowledge and skills and 5 items on professional development activities. The third part is the dependent variable, teaching practice which consisted of 14 items, including teaching design, teaching implementation, academic evaluation, and collaborative education. Detailed descriptions of the variables are shown in Table 1, and the questionnaire adopts a 5-point Likert scale, with 1 indicating a high degree of conformity, 5 indicating the worst degree of conformity, and the degree of conformity decreasing with the increase of scores.

The quality of the questionnaire was tested using SPSS20.0, AMOS20.0. The results showed that the fit indices of the measurement model were CMIN/DF=3.869, NFI=0.911, RFI=0.900, IFI=0.932, TLI=0.924, CFI=0.932, RMSEA=0.085, and SRMR=0.0382. The fit indices of the structural model were CMIN/DF=3.869, NFI=0.911, RFI=0.900, IFI=0.932, TLI=0.924, CFI=0.932, RMSEA=0.085, and SRMR=0.0382. The model fit indices all reached the recommended values, which indicates that the quality of the questionnaire was good, with good reliability and validity.

Method

In order to analyse which variables are related to the teaching practice of teachers in local universities, this study used SPSS 20.0 to conduct correlation analysis. The correlation between teachers' teaching practices and digital technology resources, digital literacy skills, and professional development activities in local universities was explored, and the degree of correlation between the variables was examined.

To explore the differences in the influence of digital technology resources, teachers' digital knowledge and skills, and teachers' professional development activities on teachers' teaching practices, digital technology resources, teachers' digital knowledge and skills, and teachers' professional development activities were taken as independent variables, and teaching practices as the dependent variable, and stepwise regression was used for significance testing.

In order to analyse whether digital knowledge skills and professional development activities play a mediating role in the process of digital technology resources affecting teaching practice, digital technology resources as the independent variable, teaching practice as the dependent variable, and digital knowledge skills and professional development activities as the mediating variables were tested for mediating effects by using SPSS 20.0 with regression analysis and Model 4 in Process to investigate their significance. The significance was investigated using SPSS20.0 with regression analysis and model 4 in Process.

RESULTS

Analysis of factors related to teachers' teaching practice

Table 2 shows the data analysed for the factors related to teaching practice. In terms of mean values, all variables are in the range of relatively good and general. In contrast, the level of professional development activities is higher and close to relatively good. Teaching practice of teachers in local colleges and universities is significantly and positively correlated with digital technology resources of schools, digital knowledge skills of teachers, and professional development activities of teachers, in which teaching practice is highly correlated with digital knowledge skills (r=0.887), and teaching practice is moderately correlated with digital technology resources and professional development activities (r=0.657, 0.761). Digital technology resources, teachers' digital knowledge skills, and teachers' professional development were correlated with each other, and all of them were significantly positively correlated. It can be hypothesized that it is necessary to pay attention to digital technology resources, teachers' digital knowledge skills, and teachers' professional development in order to improve the effectiveness of teachers' teaching practice.

Regression analysis of the influence of digital technology resources on teachers' teaching practice

Table 3 shows the regression analysis of the influence of digital technology resources and its elements on teachers' teaching practice. The influence of digital technology resources and each item of digital technology resources on teachers' teaching practice is analysed by taking digital technology resources and teaching practice as independent variables and teaching practice as dependent variable. The results of the statistical data (see Table 3) show that

[1] *Notice of the Ministry of Education on the Issuance of Education Industry Standards for "Teacher Digital Literacy". Ministry of Education of the People's Republic of China.* URL: http://www.moe.gov.cn/srcsite/A16/s3342/202302/t20230214_1044634.html.

Table 1. *Descriptive analysis of variables*
Таблица 1. *Дескриптивный анализ переменных*

Variables		Variable description	Maximum value	Minimum value	Mean value	Standard deviation
Availability and usage of digital technology resources		General educational software provided by schools for teachers	1	5	2.42	1.035
		Subject-specific software for education and teaching provided by schools for teachers	1	5	3.15	1.146
		Digital educational resources provided by schools for teachers	1	5	2.56	1.055
		Smart education platforms provided by schools for teachers	1	5	2.26	0.992
		Intelligent analysis and evaluation tools related to education and teaching provided by schools for teachers	1	5	2.79	1.165
		The number of smart classrooms in schools	1	5	2.47	1.040
Digital knowledge and skills	**Knowledge**	Understand the connotative characteristics of common digital technologies	1	5	2.33	0.933
		Be able to propose procedures and methods for problem-solving in the use of digital technologies	1	5	2.49	0.973
	Skills	Master the principles and methods of selecting digital devices, software, and platforms in education and teaching	1	5	2.50	0.941
		Proficiently operate digital devices, software, and platforms to solve common problems	1	5	2.50	0.883
Professional development	**Learning and professional development**	Be able to carry out learning by utilizing digital technology resources according to personal development needs	1	5	2.06	0.888
		Be able to analyze personal teaching practice by using digital technology resources to support teaching reflection and improvement	1	5	2.15	0.930
		Be able to participate in or preside over online professional development communities, learn together, share experiences, seek help, and solve problems	1	5	2.20	0.958
	Teaching research and innovation	Be able to use digital technology resources to support teaching research activities in response to digital teaching problems	1	5	2.19	0.920
		Be able to continuously innovate teaching models, improve teaching activities, and transform students' learning styles by using digital technology resources	1	5	2.18	0.931
Teaching practice	**Teaching design**	Be able to use digital evaluation tools to analyze students' learning situations	1	5	2.52	0.927
		Be able to collect from multiple channels, and select, manage, and create digital educational resources according to teaching needs	1	5	2.51	0.908
		Be able to design teaching activities that integrate digital technology resources according to teaching objectives	1	5	2.45	0.890

Continue of table 1

Variables		Variable description	Maximum value	Minimum value	Mean value	Standard deviation
Teaching practice	Teaching design	Be able to use digital technology resources to break through the limitations of time and space, and create a learning environment that integrates the online learning space and the physical learning space	1	5	2.52	0.943
	Teaching implementation	Be able to use digital technology resources to organize teaching activities in an orderly manner, and enhance students' participation and initiative in communication	1	5	2.46	0.927
		Be able to use digital tools to collect students' feedback, improve teaching behaviors, optimize teaching links, and regulate the teaching process	1	5	2.45	0.932
		Be able to use digital technology resources to identify students' learning differences and provide targeted guidance	1	5	2.49	0.927
	Academic evaluation	Be able to reasonably select and use digital tools to collect multimodal academic evaluation data	1	5	2.59	0.961
		Be able to select and apply appropriate data analysis models to conduct academic data analysis	1	5	2.64	0.994
		Be able to visualize the results of academic data analysis with the help of digital tools and provide reasonable interpretations	1	5	2.57	0.998
	Collaborative education	Be able to guide students to appropriately select and use digital technology resources to support their learning, and pay attention to cultivating students' computational thinking and digital social responsibility	1	5	2.51	0.946
		Be able to use digital technology resources to broaden the channels of moral education and innovate the moral education model	1	5	2.48	0.941
		Be able to use digital technology resources to assist in carrying out various forms of mental health education activities	1	5	2.63	0.984
		Be able to use digital technology resources to achieve collaborative education between schools and families, actively strive for social resources, and broaden the channels of education	1	5	2.58	0.993

Table 2. *Analysis of factors related to teaching practice*
Таблица 2. *Анализ факторов, связанных с преподавательской практикой*

Variables	M	SD	1	2	3
1 Teaching practice	2.528	0.848	–		
2 Digital technology resources	2.609	0.895	0.657***	–	
3 Digital knowledge and skills	2.455	0.855	0.887***	0.626***	–
4 Professional development activities	2.155	0.864	0.761***	0.517***	0.683***

*Note. *** is p<0.001; M is the mean; SD is the standard deviation.*
*Примечание. *** p<0,001; M – среднее значение; SD – стандартное отклонение.*

Table 3. *Summary table of regression analysis on the influence of teaching technology resources and their various elements on teachers' teaching practice*
Таблица 3. *Сводная таблица регрессионного анализа влияния ресурсов образовательных технологий и их отдельных компонентов на преподавательскую практику*

Independent variable	R^2	F	β	t
Teaching technology resources	0.431	299.956^{***}	0.657	17.319^{***}
General educational software provided by the school for teachers in education and teaching	–	102.673^{***}	–	–
Subject-specific software used in education and teaching provided by the school for teachers	–		–	–
Digital educational resources provided by the school for teachers	–		–	–
Smart education platforms provided by the school for teachers	0.068		0.269	4.887^{***}
Intelligent analysis and evaluation tools related to education and teaching provided by the school for teachers	0.351		0.287	5.308^{***}
The number of smart classrooms provided by the school for teachers	0.020		0.198	3.704^{***}

*Note. *** is p<0.001. Independent variables: Digital technology resources (General educational software provided by the school for teachers in education and teaching; Subject-specific software used in education and teaching provided by the school for teachers; Digital educational resources provided by the school for teachers; Smart education platforms provided by the school for teachers; Intelligent analysis and evaluation tools related to education and teaching provided by the school for teachers; The number of smart classrooms provided by the school for teachers). Dependent variable: Teaching practice. R^2 is coefficient of determination; β is standardized regression coefficient.*

*Примечание. *** p<0,001. Независимые переменные: цифровые образовательные ресурсы, предоставляемые преподавателям учебным заведением (общее образовательное программное обеспечение для образования и преподавания; предметно-ориентированное программное обеспечение для образования и преподавания; цифровые образовательные ресурсы; «умная» образовательная платформа; инструменты интеллектуального анализа и оценки, связанные с обучением и преподаванием; количество «умных» аудиторий). Зависимая переменная: преподавательская практика. R^2 – коэффициент детерминации; β – стандартизированный коэффициент регрессии.*

the influence of digital technology resources on teachers' teaching practice is 43.1 %. Among the items of digital technology resources, "smart education platform provided by the school to teachers" (with an explanatory power of 6.8 %), "intelligent analysing and evaluating tools related to teaching and learning provided by the school to teachers" (with an explanatory power of 35.1 %), "the number of smart classrooms provided by the school to teachers" (explanatory power of 2 %) had a positive impact on teaching practice. The three variables of general software for education and teaching provided to teachers by the school, subject software used in education and teaching provided to teachers by the school, and digital educational resources provided to teachers by the school were excluded from the model due to their small influence. In the process of digital technology resources affecting teaching practice, the intelligent analysis and evaluation tools related to education and teaching played the most important role, with a 35.1 % contribution.

Analysis of the mediating effect of digital knowledge skills and professional development activities

Based on the previous literature review and theoretical analysis, we hypothesize that digital technology resources can influence teachers' digital knowledge skills and professional development activities, thus affecting teaching practices. In order to test this hypothesis, digital knowledge skills and professional development activities were taken as the mediating variables, digital technology resources as the independent variables, and teaching practice as the dependent variable, and the significance of the mediating effect was investigated. The results of the study showed that (see Table 4), the direct effect was significant, the mediating effect was significant, the total mediating effect was significant, and the total effect was significant. The total effect was 0.6223, and the influence of all variables on teaching practice was 62.23 %. The direct effect of digital technology resources was 0.1202, with an influence of 12.02% on teaching practice; the mediating effect of digital knowledge and skills (M1) was 0.3699, with an influence of 36.99 % on teaching practice; the mediating effect of professional development activities (M2) was 0.1322, with an influence of 13.22 % on teaching practice; the total mediating effect (M1+M2) was 0.521, and the influence on teaching practice was 52.1 %.

Among all the effects of digital technology resources on teaching practice, 19.32 % of the effect is played by digital technology resources; 80.68 % of the effect is played by digital knowledge and skills and professional development

Table 4. *Mediating effect analysis on digital knowledge skills and professional development activities*
Таблица 4. *Анализ опосредующего эффекта цифровых знаний, навыков и профессионального развития*

Name	Estimated value	Standard error (SE)	95 % Confidence interval	
			Lower limit	Upper limit
Total	0.6223	0.0359	0.5517	0.6930
c′	0.1202	0.0247	0.0717	0.1687
M1	0.3699	0.0369	0.2978	0.4435
M2	0.1322	0.0231	0.0908	0.1816
M1+M2	0.5021	0.0386	0.4253	0.5774

Note. Dependent variable: digital technology resources; independent variable: teaching practice; c′ is direct effect; mediating variables: M1 is digital knowledge and skills; M2 is professional development activities.

Примечание. Зависимая переменная: ресурсы цифровых технологий; независимая переменная: преподавательская практика; c′ – прямой эффект; опосредующие переменные: M1 – цифровая компетентность; M2 – профессиональное развитие.

activities, of which digital knowledge and skills play a role of 59.44 % and professional development activities play a role of 21.24 %. It can be inferred that digital technology resources have significantly enhanced the impact on teaching practice through the mediation of digital knowledge skills and professional development activities.

In order to further analyse which items of digital literacy skills and professional development activities had significant mediating effects, multiple mediation effect tests were conducted with each variable of the two dimensions as mediator variables in the equations. The statistical results show (see Table 5) that the mediating effects of the four variables in the dimension of digital knowledge and skills are all significant, that is, understanding the connotation and characteristics of common digital technologies (M1-1), being able to propose procedures and methods for solving problems in the use of digital technologies (M1-2), mastering the principles and methods of selecting digital equipment, software and platforms in education and teaching (M1-3), and being skilled in the operation and use of digital equipment, software and platforms in solving common problems (M1-4) played a positive mediating role. The influence of the four variables on teaching practice was 7.64 %, 7.39 %, 10.35 %, and 11.28 %, respectively. In contrast, the mediating effects of proficiency in using digital devices, software and platforms, solving common problems, and mastering the principles and methods of selecting digital devices, software and platforms in teaching and learning were larger.

In the dimension of professional development activities, only two variables have significant mediating effects, that is, being able to participate in or host a web-based training community to learn together, share experiences, seek help, and solve problems (M2-3); and being able to utilize digital technology resources to continuously innovate the teaching mode, improve the teaching activities, and change the students' learning styles (M2-5) both play a positive mediating effect, and the influences of these two variables on the teaching practice are 5.61 % and 7 % respectively. The mediating effects of the variables of being able to use digital technology resources to carry out learning according to personal development needs (M2-1); being able to use digital technology resources to analyse personal teaching practices and support teaching reflection and improvement (M2-2); and being able to use digital technology resources to support teaching and learning research activities in response to the problems of digital teaching and learning (M2-4) were not significant.

DISCUSSION

Digital technology resources, digital literacy skills, and professional development activities can synergistically influence teachers' instructional practices

Digital technology resources serve as the material foundation for teaching practices. Teachers' digital knowledge and skills act as the intermediary for the transformation of teaching practices, and professional development provides the continuous driving force for teaching practices. This is similar to the research results of Li Ziyi, Qiao Shiwei and others [25; 26]. These three elements jointly empower teachers' teaching practices and enhance the quality of teaching. Statistical results show that teaching practice is highly correlated with digital technology resources, digital knowledge and skills, and professional development activities, and this strong correlation indicates that these three factors are directly related to teachers' teaching practice. In the process of empowering teaching practice, all three factors play a positive role, and the synergistic development of the three factors can more effectively empower teachers' teaching practice.

Digital technology resources are a core driving factor in empowering teaching and learning practices in higher education

Digital technology resources play a 43.1 % role in empowering teaching practice, this is the same as the existing research results [27], which reflects the value of digital

Table 5. *Mediating effect analysis on various elements of digital knowledge skills and professional development activities*
Таблица 5. *Анализ посреднического эффекта отдельных элементов цифровых компетенций и профессионального развития*

Effect and Mediating variables	Estimated value	SE	95 % confidence interval	
			Lower limit	Upper limit
Total	0.6223	0.0359	0.5517	0.6930
Direct effect (c′)	0.1292	0.0247	0.0806	0.1779
Understand the connotative characteristics of common digital technologies (M1-1)	0.0764	0.0313	0.0152	0.1359
Be able to propose procedures and methods for problem solving in the use of digital technologies (M1-2)	0.0739	0.0300	0.0155	0.1343
Master the principles and methods of selecting digital devices, software, and platforms in education and teaching (M1-3)	0.1035	0.0327	0.0398	0.1687
Proficiently operate digital devices, software, and platforms to solve common problems (M1-4)	0.1128	0.0317	0.0595	0.1832
Be able to carry out learning by utilizing digital technology resources according to personal development needs (M2-1)	−0.0330	0.0215	−0.0795	0.0071
Be able to analyze personal teaching practice by using digital technology resources to support teaching reflection and improvement (M2-2)	0.0129	0.0278	−0.0370	0.0736
Be able to participate in or preside over online professional development communities, learn together, share experiences, seek help, and solve problems (M2-3)	0.0561	0.0255	0.0025	0.1054
Be able to use digital technology resources to support teaching research activities in response to digital teaching problems (M2-4)	0.0206	0.0395	−0.0557	0.0953
Be able to continuously innovate teaching models, improve teaching activities, and transform students' learning styles by using digital technology resources (M2-5)	0.0700	0.0340	0.0098	0.1405

Note. Dependent variable: Teaching practice; independent variable: Digital technology resources; mediating variables: M1-1; M1-2; M1-3; M1-4; M2-1; M2-2; M2-3; M2-4; M2-5.

Примечание. Зависимая переменная: преподавательская практика; независимая переменная: цифровые технологические ресурсы; опосредующие переменные: M1-1; M1-2; M1-3; M1-4; M2-1; M2-2; M2-3; M2-4; M2-5.

technology resources in the teaching practice process of college teachers. The statistical results show that all variables of digital technology resources play a positive role in promoting the influence of teaching practice, but there are differences, which verifies the validity of hypothesis 1.

Intelligent analysis and evaluation tools can play a core driving role in empowering teaching practice, and the explanatory power of education and teaching-related intelligent analysis and evaluation tools on teaching practice is as high as 35.1 %, accounting for 81.4 % of the total influence of digital technology resources, which indicates that they are the core driving force to enhance teaching practice [28]. This is mainly due to the fact that intelligent analytical tools can provide diagnosis of learning conditions, analysis of classroom behaviour and feedback on teaching effects, helping teachers to make accurate teaching decisions. Their high explanatory power reflects the practical logic of data-driven teaching improvement, indicating that teachers rely more on dynamic and actionable data to support teaching optimization rather than static resource provision.

Intelligent education platforms and smart classrooms have shown positive value in the process of empowerment. As the hub of teaching management, the smart education platform (explanatory power 6.8 %) supports practical innovation through the integration of curriculum resources and standardization of teaching processes; while the smart classroom (explanatory power 2 %) improves interactive experience through the intelligent environment, but its limited contribution reflects the problem of focusing on construction rather than application of existing hardware facilities.

It is also easy to see that there are effectiveness dilemmas in the areas of generalized software, subject resources and educational resources. The correlation between these variables and teaching practice is not statistically significant. This may be due to the mismatch between resources and needs, such as generalized functions of general-purpose software, which are difficult to match the teaching scenarios of subject-specific features; high threshold of use or complex operation of subject software, and the lack of supporting training and guidance, which leads to the low utilization of digital technology resources; and fragmentation and homogenization of digital technology resources, which are difficult to directly support the design and implementation of subject teaching.

The mediating effect of digital literacy skills and professional development activities to empower teaching practice is significant

Of the total effect of digital technology resources on teaching practice, 80.68 % was realized through two mediating variables (digital knowledge and skills 59.44 % + professional development activities 21.24 %), which indicates that digital technology resources can only be effectively transformed into teaching practice through teachers' digital competence enhancement and professional development activities, and verifies the validity of hypothesis 2. This result supports that the realization of the value of digital technology resources depends on the transformation of teachers' digital competence and continuous professional growth. The mediating effect of digital knowledge and skills is significant, and the effectiveness of digital technology resources can be realized and enhanced through teachers' digital literacy, similar results have been found in the research of Pan Lifang [29]. Teachers' ability to understand, integrate and innovate digital technology resources is the key pivot for the transformation of digital technology resources into teaching practice. There is a cascading effect in digital literacy skills empowering teaching practice. The intermediary effects of "skillful operation and use of digital equipment, software, and platforms, and solving common problems" (M1-4, 11.28 %) and "mastering the principles and methods of selecting digital equipment" (M1-3, 10.35 %) are the most significant, indicating that the practical transformation of digital technology resources is highly dependent on teachers' understanding of digital technology resources and their integration and innovation. This suggests that the practical transformation of digital resources is highly dependent on teachers' operational and strategic knowledge. This result emphasizes the need for teachers to possess both operational and instructional design skills for technology integration in order to better realize digital technology resources for empowering teaching practice. The mediating effects of "understanding the connotation of digital technology" (M1-1, 7.64 %) and "proposing technological solutions" (M1-2, 7.39 %), although smaller, but not negligible. Teachers' understanding of the nature of digital technology resources and mastery of problem-solving logic is the cognitive foundation of their empowering teaching practice, the lack of which can lead to a superficial professional utility of digital technology.

Professional development activities contributed 21.24 % of the mediation effect, reflecting that they help teachers transform technological knowledge into teaching strategies, this is consistent with previous studies [30; 31], and internalize digital technology through training, teaching and research activities; promote the exchange and enhancement of technological application experience through peer exchanges, promote reflection on practice and play a positive mediation role. The significant mediating effects of "participation in online learning community" (M2-3, 5.61 %) and "utilizing technology to innovate teaching models" (M2-5, 7 %) indicate that group wisdom sharing and innovation in teaching practice are the key mechanisms of technological empowerment. This emphasizes the need for teachers to internalize technology to empower teaching practices through effective collaboration and innovative social interactions [32]. Individual learning (M2-1), independent reflection (M2-2), and pedagogical research (M2-4) did not show significant mediating effects, which may be attributed to the fact that teachers are unable to break through the cognitive limitations due to the lack of external feedback on their individual learning; independent reflection, which lacks the support of effective analytical tools, stays in the description of experience; and pedagogical research, which does not integrate with real classroom problems, lacks precise application. Therefore, digital knowledge and skills to empower teaching practice should focus on cultivating teachers' operational ability, strategic ability and innovation ability, and organizing professional development activities focusing on external collaboration and internal innovation to build an effective empowerment path.

Policy recommendations

Building a support system for digital technology resources to empower teachers' teaching practices. First, set up special funds to optimize the construction of intelligent education platform, focusing on the procurement of teaching intelligent system with the function of learning diagnosis and classroom behaviour analysis, such as AI classroom analysis tools, supporting the construction of school-level teaching data centre.

Second, establish a demand-oriented digital technology resources development mechanism, set up a working group of university subject teachers, educational technology experts and enterprise engineers to develop intelligent teaching toolkits that fit the characteristics of the subject.

Third, implement a quality monitoring mechanism for the effectiveness of technology application, carry out annual evaluation of the effectiveness of the use of the completed smart classrooms and teaching platforms, and incorporate the utilization rate of the equipment and the output of teaching innovation cases into the assessment system of faculties and colleges.

Implementing tiered instruction for teachers' digital literacy skills empowering instructional practices. First of all, build teachers' digital knowledge and skills layered training system:

– the basic layer focuses on cultivating equipment operation ability, which can be assessed through the micro-certification system to assess the proficiency of equipment operation;

– the enhancement layer strengthens the technology integration ability, and carries out workshops based on the in-depth fusion of intelligent technology and subject teaching;

– the innovation layer fosters the ability of data-driven decision-making, and establishes a training program for the analysis of teaching and learning big data.

Secondly, we set up a dual-mentor guidance team for teaching practice, equip teachers' teams with digital technology mentors and subject teaching mentors by course teams, and collaborate in designing technology-integrated lesson plans.

Thirdly, we create a community of practice for teachers, build a digital teaching case base for subjects, and regularly organize cross-faculty exhibitions of the results of technological application.

Innovative organizational models for teacher professional development activities to empower teaching practice. Firstly, implement the teaching and research mode driven by the actual problems of education and teaching, focusing on the interpretation of classroom behaviour data, personalized teaching strategies and other real problems, and carry out online case studies and offline practical exercises combined with teaching and research.

Secondly, set up a special topic for research on the application of digital technological resources, which requires that the topic team must include digital technicians, subject teachers and tutors, and that the results of the research should be embedded in the actual teaching and learning process.

Thirdly, regular teaching practice exchange meetings are organized, and experts are sent to guide teachers to accurately interpret classroom intelligence analysis reports, establish a system of regular teaching reflection meetings based on data analysis, and incorporate reflections on the application of digital technology resources into teachers' development files.

CONCLUSIONS

Digital technology resources, teachers' digital literacy skills and professional development activities into a synergistic enabling mechanism

Digital technology resources, teachers' digital knowledge and skills, and professional development activities have significant synergistic effects on the teaching practice of college teachers (high and medium positive correlation), with digital technology resources as the material foundation (r=0.657), teachers' knowledge and skills as the transformational intermediary (r=0.887), and professional development activities as the sustained motivational intermediary (r=0.761). The three elements need to be systematically linked, and any single input will reduce the effectiveness of teaching practice.

Intelligent analytics tools are the core drivers of digital technology resources that empower teaching and learning practices

Intelligent analysis and evaluation tools in digital technology resources have an explanatory power of 35.1 % (81.4 % of the total effectiveness of technology resources), and their data-driven learning diagnosis and teaching feedback functions have become the key to teaching practice. General software, subject software and digital educational resources do not have a significant impact, probably due to the generalization of the functions of digital technology resources (such as, the lack of subject adaptability), the complexity of the operation and the fragmentation of the resources, and the imprecise matching between the supply of digital technology resources and the teaching demand in the teaching practice of local colleges and universities.

Teachers' digital literacy skills and professional development activities show a cascading progression of empowering instructional practice pathways

Among the mediating effects of digital knowledge and skills, the direct influence of technology operation ability is the most significant, and the direct influence of technology essence cognition and innovative solution ability form an implicit basis. The effectiveness of professional development activities relies on social collaboration mechanisms, such as web-based learning communities and innovation of technology-integrated teaching modes; while individual learning, independent reflection and pedagogical research are not effective due to the lack of the necessary support.

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Развитие потенциала преподавателей региональных вузов с помощью цифровых ресурсов: логика и практические механизмы

Ли Чуньцзян[1], доктор философии, профессор, президент
Чжао Мэнфэй[2], аспирант
Юй Хайин*[3], доктор педагогических наук, профессор, декан факультета педагогики
Муданьцзянский педагогический университет, Муданьцзян (Китай)

***E-mail:** 0701008@mdjnu.edu.cn

[1]ORCID: https://orcid.org/0009-0004-2589-4327
[2]ORCID: https://orcid.org/0009-0009-9564-862X
[3]ORCID: https://orcid.org/0000-0003-0157-4631

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Аннотация: В условиях искусственного интеллекта и цифровой трансформации образования актуален вопрос о том, как цифровые технологические ресурсы расширяют возможности преподавательской деятельности в региональных университетах. Исследование опирается на данные, полученные в ходе изучения преподавательской деятельности в трех региональных вузах провинции Хэйлунцзян, Китай. Выявлено, что цифровые технологические ресурсы, цифровая компетентность преподавателей и мероприятия по повышению квалификации формируют механизм, способствующий укреплению преподавательской практики и ее продвижению в региональных университетах. Инструменты интеллектуального анализа являются ключевой движущей силой цифровых технологических ресурсов; их функции диагностики обучения на основе данных и обратной связи становятся центральными элементами образовательного процесса. Цифровая компетентность преподавателей и мероприятия по повышению их квалификации играют значимую опосредующую роль, демонстрируя поэтапный иерархический процесс расширения возможностей преподавательской практики. Для повышения эффективности использования цифровых технологических ресурсов в преподавательской практике региональных университетов необходимо сформировать систему поддержки цифрового сопровождения педагогической деятельности, реализовать иерархически выстроенное сопровождение процесса формирования цифровой компетентности преподавателей, а также внедрять инновационные модели мероприятий по повышению квалификации.

Ключевые слова: региональные университеты; цифровые технологические ресурсы; цифровая грамотность; профессиональное развитие; преподавательская практика.

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