

# Factors Influencing Middle School Teachers' Willingness to Use Interactive Whiteboards in Huaibei, China

Rui Guo\*

Received: August 26, 2026. Revised: September 17, 2025. Accepted: October 4, 2025.

---

## Abstract

**Purpose:** This study aims to explore the key factors influencing middle school teachers' intention to use interactive whiteboards in teaching by integrating the Unified Theory of Acceptance and Use of Technology (UTAUT) model, Innovation Diffusion Theory (IDT), and the Technological Pedagogical and Content Knowledge (TPACK) framework, in order to support the deep integration of technology and educational practices. **Research design, data and methodology:** Using quantitative research methods, this study investigated 269 teachers from 5 middle schools in Huaibei City, Anhui Province through questionnaire surveys. Data analysis was conducted using SPSS 26.0 and AMOS 26.0, including descriptive statistics, confirmatory factor analysis, and structural equation modeling. **Results:** The results indicate that attitude, performance expectancy, and effort expectancy are the main factors influencing behavioral intentions. Computer self-efficacy and TPACK ability also have significant impacts, while social influence is relatively weak and facilitating conditions have not yet formed an effective driving force. **Conclusions:** Teachers' behavioral intentions follow a three-level influence mechanism of "intrinsic drive - ability transformation - environmental assistance". This study proposes strategies to promote the transformation of interactive whiteboards from passive adaptation tools to active innovation engines, thereby enhancing teachers' willingness to use them and facilitating the deep integration of technology and teaching.

**Keywords:** Interactive Whiteboard, Technology Acceptance Model, Middle school teachers

**JEL Classification Code:** I21, O33, M15, L86

---

## 1. Introduction

In recent years, technology-informed teaching has gradually become a focus of educational policy and research. Although information technology has profoundly influenced many industries, its rapid development has not yet brought the expected benefits to the education sector. Most teachers and students remain unable to effectively apply information technology in actual classroom settings. Although technological tools have proliferated, their impact on improving teaching and learning outcomes remains limited. This phenomenon is known as the "productivity paradox" of information technology (Zhang, 2016), highlighting a critical issue: the mere adoption of new tools does not guarantee improved educational outcomes.

The root of this problem lies in users' (teachers') resistance and lack of willingness to accept and utilise information technology. Rogers (2003) emphasised that human factors are key to building a technology-informed educational environment. Similarly, Torkzadeh and Doll (1988) identified "user acceptance" as a critical determinant of value generated by information systems. These insights indicate that research must look beyond a technical perspective and explore individual factors influencing users' willingness to use technology. This is particularly important for middle school teachers, who play a crucial role in shaping students' learning experiences.

In the Chinese education system, middle school teachers play a vital role in basic education. According to national laws and regulations, such as the Compulsory Education

---

<sup>1</sup> \*Rui Guo, Huaibei No. 1 High School Anhui Province, China.  
Email: 806987666@qq.com

© Copyright: The Author(s)

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Law and the Teacher Law, middle school teachers encompasses educators working in both junior high schools (grades 7-9) and senior high schools (grades 10-12). Teachers are required to hold corresponding teaching qualifications and are responsible for teaching and student development at the secondary education level. This study mainly focuses on the latter, namely teachers at the senior high school level.

The Interactive Whiteboard (IWB) represents a comprehensive application and integration of information technology. Through functions such as touch interaction, data integration, and network collaboration, IWBs are deeply embedded in the software and hardware systems of information technology and serve as a typical tool for implementing educational informatisation. Higgins et al. (2007) pointed out that the popularisation of interactive whiteboards marks the transition of educational informatisation from “tool assistance” to “technological ecological restructuring.”

Although China has invested heavily in information technology infrastructure, many primary and secondary schools have underutilised these resources. Teachers use technological tools only in open classes or teaching competitions, and some even avoid daily use (Chen & Liu, 2020). This underutilisation stems from complex factors influencing teachers’ willingness to adopt technology. At present, relatively little research focuses on the mechanism of influencing interactive whiteboard teaching applications from the individual perspective of middle school teachers.

Therefore, this study aims to integrate the UTAUT model, Innovation Diffusion Theory, and the TPACK framework to investigate the key factors influencing middle school teachers’ willingness to use interactive whiteboards and the relationships between these factors. Based on the findings, effective strategies and recommendations will be proposed to enhance teachers’ willingness and ability to use IWBs, thereby contributing to the high-quality development of educational informatisation and supporting educational reform.

## 2. Literature Review

### 2.1 Performance Expectancy

Performance Expectancy (PE) is defined as the degree to which an individual believes that using a technology will help them to achieve gains in job performance (Venkatesh et al., 2003). In the context of this study, it refers to middle school teachers' belief that using interactive whiteboards (IWBs) can enhance their teaching quality and facilitate the acquisition of new knowledge and skills.

Substantial literature within models like TAM and

UTAUT has established PE as a robust predictor of user acceptance, particularly in educational settings. Empirical evidence consistently demonstrates that PE significantly influences both attitudes and behavioral intentions toward technology use. Teachers are more likely to form positive attitudes and adopt technologies when they perceive them as effective tools for improving instructional outcomes (Davis, 1989; Scherer et al., 2019; Teo, 2011; Venkatesh et al., 2003).

However, while the general effect of PE is well-documented, its specific impact within the context of IWB adoption among middle school teachers warrants further investigation. Much of the existing research focuses on technology acceptance in a broad sense or in higher education, leaving a gap in understanding the unique drivers for this specific technology and teacher demographic.

Therefore, this study aims to validate and extend these established relationships by specifically examining the role of PE in the acceptance of IWBs. Based on the strong theoretical and empirical foundation, the following hypotheses are proposed:

**H1:** Performance Expectancy has a direct positive effect on middle school teachers' attitude toward using interactive whiteboards.

**H2:** Performance Expectancy has a direct positive effect on middle school teachers' behavioral intention to use interactive whiteboards.

### 2.2 Effort Expectancy

Effort Expectancy (EE) is defined as the degree of ease associated with the use of a technology (Venkatesh et al., 2003). In this study, it specifically refers to the perceived level of difficulty middle school teachers associate with using interactive whiteboards (IWBs).

The negative relationship between perceived effort and adoption intention is a cornerstone of technology acceptance models like TAM and UTAUT. Extensive empirical research has consistently confirmed that EE is a critical determinant of behavioral intention, particularly in the initial stages of technology implementation. When teachers perceive a technology as easy to use and free from excessive complexity, they demonstrate a stronger willingness to adopt it (Venkatesh et al., 2003; Scherer et al., 2019; Teo, 2011). This relationship has been validated across diverse educational contexts, including research on Singaporean teachers (Teo, 2011) and middle school teachers (Niu, 2018).

Despite this well-established general relationship, its nuanced application within the specific context of IWB integration in middle schools remains less explored. The unique features and functionalities of IWBs may present distinct ease-of-use challenges that are not fully captured by broader technology acceptance studies.

Therefore, this study seeks to reaffirm the role of EE in

the specific scenario of IWB adoption among middle school teachers. Based on the overwhelming theoretical and empirical support, the following hypothesis is proposed:

**H3:** Effort Expectancy has a direct positive effect on middle school teachers' behavioral intention to use interactive whiteboards.

### 2.3 Social Influence

Social Influence (SI) is defined as the degree to which an individual perceives that important others (e.g., colleagues, school management, parents) believe they should use the new technology (Venkatesh et al., 2003). In this study, it refers to the perceived pressure and support from the social environment that influences middle school teachers' decisions to use interactive whiteboards.

According to the UTAUT, the Theory of Planned Behavior (TPB), SI is considered an important direct predictor of behavioral intention, particularly in contexts involving mandatory or early-stage adoption. Empirical evidence robustly supports this, indicating that the endorsements, expectations, and behaviors of superiors, colleagues, and students can profoundly shape teachers' technology adoption decisions. Studies have shown that SI significantly impacts both the initial and continued use of technology, with support from school management and colleagues being a critical facilitating condition (Venkatesh et al., 2003; Scherer et al., 2019; Teo, 2011).

While the general effect of SI is well-established, its specific operational dynamics and relative strength within the unique social ecosystem of a middle school—encompassing principals, fellow teachers, students, and parents—require further contextualized investigation. Most studies treat SI as a monolithic construct, potentially overlooking how different sources of influence vary in their impact on teachers' intentions regarding a specific technology like IWBs.

Therefore, this study aims to examine the specific role of SI in driving IWB adoption intention among middle school teachers, contributing to a more nuanced understanding of its function in this setting. Based on the strong theoretical foundation, the following hypothesis is proposed:

**H4:** Social Influence has a direct positive effect on middle school teachers' behavioral intention to use interactive whiteboards.

### 2.4 Facilitating Conditions

Facilitating Conditions (FC) are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system (Venkatesh et al., 2003). In this study, it encompasses the specific external support—such as technological

infrastructure, training, and policy environment—provided by schools to enable the use of interactive whiteboards (IWBs).

The UTAUT model posits that FC significantly influences usage behavior, particularly in the post-adoption stages. This relationship is corroborated by empirical research across educational contexts. Studies confirm that the availability of adequate resources, reliable technical support, and relevant training are critical factors that enhance teachers' intention and actual ability to use technology. When teachers perceive that sufficient support structures are in place, their willingness to adopt and integrate technology into teaching is strengthened (Venkatesh et al., 2003; Scherer et al., 2019; Teo, 2011).

However, while the importance of FC is recognized, its specific composition and relative impact within the context of IWB implementation in middle schools are not yet fully understood. The existing literature often treats FC as a broad construct, potentially overlooking which specific facilitating factors are most critical for motivating teachers' behavioral intention towards this particular technology.

Therefore, this study aims to clarify the role of FC in shaping the behavioral intention to use IWBs among middle school teachers, providing insights into the most impactful types of support. Grounded in established theory and evidence, the following hypothesis is proposed:

**H5:** Facilitating Conditions have a direct positive effect on middle school teachers' behavioral intention to use interactive whiteboards.

### 2.5 Computer Self-efficacy

Computer Self-efficacy (CSE) is defined as an individual's judgment of their capability to use computers and related technologies to complete specific tasks (Compeau & Higgins, 1995). This construct is rooted in Bandura's (1977) self-efficacy theory. In this study, it refers to middle school teachers' confidence in their ability to operate interactive whiteboards and integrate them effectively into their teaching practices.

Extensive research, grounded in self-efficacy theory and the Technology Acceptance Model (TAM), has established CSE as a critical antecedent to both attitudes and behavioral intentions. Empirical evidence consistently demonstrates that individuals with high CSE are more likely to form positive attitudes towards technology, exhibit greater willingness to use it, and persist in the face of challenges. Specifically in education, teachers with higher CSE show more proactive technology adoption and integration behaviors (Compeau & Higgins, 1995; Scherer et al., 2019; Teo, 2009; Venkatesh et al., 2008).

Despite the well-documented importance of CSE, its specific impact within the context of interactive whiteboard

(IWB) adoption among middle school teachers remains underexplored. Furthermore, the mechanisms through which CSE influences both attitude and intention simultaneously in this specific context require further empirical validation.

Therefore, this study aims to investigate the dual-path influence of CSE on both teachers' attitudes and their behavioral intentions regarding IWB use, thereby contributing to a more nuanced understanding of its role in the acceptance of advanced educational technologies. Based on the strong theoretical and empirical foundation, the following hypotheses are proposed:

**H6:** Computer Self-efficacy has a direct positive effect on middle school teachers' attitude toward using interactive whiteboards.

**H7:** Computer Self-efficacy has a direct positive effect on middle school teachers' behavioral intention to use interactive whiteboards.

## 2.6 TPACK

Technological Pedagogical Content Knowledge (TPACK) is defined as a teacher's integrative knowledge framework that encompasses the complex interplay among Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) for effective technology-enhanced teaching (Mishra & Koehler, 2006). In this study, it refers to the capability of middle school teachers to effectively integrate interactive whiteboards (IWBs) into their subject-specific teaching practices.

The TPACK framework posits that this integrative knowledge is a critical determinant of successful technology integration, influencing both teachers' beliefs and their instructional behaviors. Empirical research supports that teachers with higher TPACK levels hold more positive attitudes toward technology use and possess stronger beliefs in its ability to improve performance (performance expectancy), as they are more confident in their ability to leverage technology to enhance teaching and learning outcomes (Chai et al., 2013; Mishra & Koehler, 2006; Scherer et al., 2019).

However, while the TPACK framework is widely accepted, empirical research specifically linking TPACK capability to key technology acceptance determinants, such as attitude and performance expectancy, in the context of IWB adoption remains limited. Most studies focus on TPACK as an outcome measure, and its role as a direct antecedent influencing the psychological drivers of adoption (like attitude and performance expectancy) warrants further investigation, particularly among middle school teachers.

Therefore, this study aims to bridge this gap by empirically examining the direct influence of TPACK capability on teachers' attitudes and their performance

expectations regarding IWB use. Based on the theoretical propositions of the TPACK framework and supporting evidence, the following hypotheses are proposed:

**H8:** TPACK capability has a direct positive effect on middle school teachers' attitude toward using interactive whiteboards.

**H9:** TPACK capability has a direct positive effect on middle school teachers' performance expectancy of using interactive whiteboards.

## 2.7 Attitude

Attitude (AT) is defined as an individual's overall affective evaluation of, or emotional response to, the act of using a technology (Ajzen, 1991; Davis, 1989). In this study, it refers to the positive or negative feelings middle school teachers hold towards using interactive whiteboards in their teaching practice.

Attitude is a foundational construct in influential theories like TAM and TPB, where it is posited as a key proximal determinant of behavioral intention. Empirical research robustly supports this relationship across educational contexts. Studies consistently show that teachers who form a positive attitude towards a technology, often based on their knowledge and prior experiences, demonstrate a significantly stronger intention to use it (Ajzen, 1991; Davis, 1989; Scherer et al., 2019; Teo, 2011). This is further supported by Innovation Diffusion Theory, which positions attitude formation as a critical stage in the technology adoption process (Rogers, 2003).

While the direct link between attitude and intention is well-established, the antecedent factors that specifically shape middle school teachers' attitudes towards Interactive Whiteboards (IWBs) require further investigation. Most studies focus on attitude as an outcome or a mediator, but the unique cognitive and affective drivers of attitude within the specific context of IWB integration—considering its interactive and collaborative features—are not fully explored.

Therefore, this study seeks to validate the fundamental role of attitude in the context of IWB adoption and to explore its antecedents. Based on the strong consensus from theory and prior evidence, the following hypothesis is proposed:

**H10:** Attitude toward using interactive whiteboards has a direct positive effect on middle school teachers' behavioral intention to use them.

## 2.8 Behavioral Intention

Behavioral Intention (BI) is defined as the degree to which a person has formulated conscious plans to perform or not perform some specified future behavior (Ajzen, 1991;

Venkatesh et al., 2003). In this study, it refers to the strength of middle school teachers' willingness and plan to use interactive whiteboards (IWBs) in their future teaching activities, serving as a key proximal predictor of their actual usage behavior.

Behavioral intention is a central construct in dominant technology acceptance theories, including the Theory of Planned Behavior (TPB) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Extensive empirical research has consistently validated that BI is the most immediate and powerful determinant of actual technology use. A strong behavioral intention indicates a high likelihood of subsequent adoption and implementation (Ajzen, 1991; Scherer et al., 2019; Teo, 2011; Venkatesh et al., 2003).

Given its established role as the ultimate dependent variable in acceptance models, the primary research focus is not on establishing the existence of BI itself, but rather on identifying its key antecedents. While numerous factors (e.g., performance expectancy, attitude) are known predictors of intention, their relative importance and interplay within the specific context of IWB adoption by middle school teachers are not yet fully elucidated.

Therefore, this study does not propose a new hypothesis for BI itself but rather positions it as the critical outcome variable to be explained. The core objective is to investigate and quantify the effects of the previously mentioned factors (Performance Expectancy, Effort Expectancy, etc.) on this behavioral intention. The cumulative influence of these factors on BI will be empirically tested within the proposed research model.

### 3. Research Methods and Materials

#### 3.1 Research Framework

A conceptual framework presents the key constructs, variables, and their hypothesized relationships in a study through visual or narrative means (Miles et al., 2014). The framework of this study is constructed by integrating four fundamental theories to comprehensively understand the factors that influence the behavioral intention of middle school teachers to use interactive whiteboards (IWBs).

Firstly, the UTAUT (Venkatesh et al., 2003), in its revised form (Dwivedi et al., 2017), serves as the core model. It posits that PE, EE, SI, and FC are key drivers of behavioral intention, with Attitude playing a central mediating role.

Dwivedi et al. (2017) proposed an improved theoretical model for information systems/information technology acceptance and use based on meta-analysis (covering 1600 observations from 162 studies) and structural equation modeling. The study found that attitude not only indirectly

affects usage behavior through behavioral intention, but also has a direct effect on it, which is consistent with multiple previous studies. The model revised the original UTAUT framework, excluded four moderating variables, and introduced the influence of "facilitation conditions" on behavioral intention, as well as "user attitude" as a mediating variable. This revision significantly enhances the explanatory power of the model and provides a more comprehensive theoretical basis for understanding the acceptance mechanism of IS/IT innovation.

Second, the Theory of Planned Behavior (TPB) (Ajzen, 1991) supplements the framework by emphasizing the significance of attitude and introducing computer self-efficacy (a core component of perceived behavioral control) as a critical antecedent directly influencing both attitude and behavioral intention.

Thirdly, as TPACK is the fundamental knowledge for teachers to use technology in teaching in the information age, this article also draws on TPACK from the field of education. The TPACK framework (Mishra & Koehler, 2006) suggests that TPACK ability directly shapes teachers' efficacy beliefs (PE) and attitude. The TPACK competency framework includes Content Knowledge (CK), Pedagogical Knowledge (PK), and Technical Knowledge (TK), which are intertwined and together constitute a teacher's TPACK competency, affecting their teaching effectiveness. The stronger the TPACK ability, the higher the teacher's expectations and confidence in technology to improve teaching effectiveness, and the more inclined they are to actively explore innovative applications of technology in teaching.

Fourth, previous studies have paid less attention to the psychological processes of teachers when accepting technology. This study introduces the theory of innovation diffusion (Rogers, 2003) to provide a theoretical basis for the adoption process and explain how knowledge shapes attitudes during the "persuasion" stage of technology adoption.

This theory divides the adoption process into five stages: cognition, persuasion, decision-making, implementation, and confirmation. Knowledge is the first stage of "innovation" acceptance. In the theory of integrating technology into teaching content knowledge, TPACK refers to the comprehensive knowledge required for teachers to integrate technology into teaching, which directly affects teachers' perception and attitude towards the value of technology in the cognitive stage (Mishra & Koehler, 2006).

The framework, shown in Figure 1, includes eight variables (PE, EE, SI, FC, CFE, TPACK, AT, and BI) and their hypothesized relationships. This study aims to empirically test this integrated model to identify the key determinants of middle school teachers' behavioral intention to use interactive whiteboards.

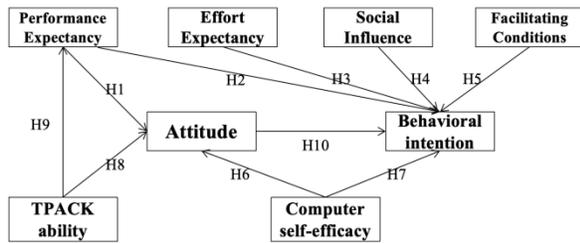


Figure 1: Research Framework

### 3.2 Research Methodology

This study employed a quantitative research design to investigate the factors influencing middle school teachers' behavioral intention to use interactive whiteboards (IWBs).

The primary research instrument was a self-administered questionnaire, designed based on established theoretical constructs and mature scales. It comprised three sections: (1) introduction and informed consent; (2) demographic information; and (3) 34 items measuring eight key variables (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Attitude, Behavioral Intention, TPACK capability, Computer Self-Efficacy) on a 5-point Likert scale.

To ensure robustness, the instrument underwent rigorous validation. Content validity was assessed by five experts via the Item-Objective Congruence (IOC) index, with all items scoring above the 0.78 threshold. Internal consistency reliability was confirmed through a pilot study (n=40); all constructs demonstrated high Cronbach's Alpha values (ranging from 0.777 to 0.861), exceeding the accepted standard of 0.7.

The data is collected online through the Wenjuanxing platform. Strict ethical protocols were adhered to, including anonymity, informed consent, and approval from an institutional ethics committee. Data analysis included descriptive statistics for sample characterization and Confirmatory Factor Analysis (CFA) followed by SEM for hypothesis testing.

### 3.3 Population and Sample Size

The target group of this study is in-service teachers (teaching grades 10-12) from five middle schools in Huaibei City, Anhui Province, China. Compared to teaching other grades, these teachers face higher teaching pressure and professional requirements, and their acceptance and use of new technological tools are highly representative. These five middle schools can all use interactive whiteboard technology equipment and receive support from basic information technology teaching environments. Most teachers have participated in the training of Information

Technology 2.0 courses and have a certain knowledge reserve and learning ability.

The research set up the effect size at 0.3 with 8 variables and 34 questionnaire items. The p-value is set up at 0.05 with the power level of 0.95. Therefore, the minimum numbers of the sample size is at 256 to detect the effect.

This study is expected to distribute approximately 300 questionnaires to in-service teachers in five middle schools in Huaibei City. The sample size of each school is allocated proportionally. Teachers from each school will be recruited based on purposive sampling. As shown in Table 1.

Table 1: Calculation of sample size

school	population	Proportion	sample size
A	312	$(256 * 100)/1481 = 18\%$	57
B	298	$(256 * 100)/1481 = 18\%$	54
C	303	$(256 * 100)/1481 = 18\%$	55
D	286	$(256 * 100)/1481 = 18\%$	52
E	282	$(256 * 100)/1481 = 18\%$	51
<b>Total</b>	1481	100%	269

Data collection was conducted via an online questionnaire administered on the Wenjuanxing platform from June to July 2025. Following a purposive sampling strategy, liaison officers from five participating schools assisted in distributing the questionnaire to target frontline teachers, while excluding non-teaching staff. Real-time monitoring and reminders were implemented to enhance response rates. Upon collection, invalid responses—such as those with patterned answers or over 10% missing key items—were excluded to ensure data quality and meet the required effective sample size.

## 4. Results and Discussion

### 4.1 Demographic Profile

Based on a pre-tested and validated questionnaire, this study collected 269 valid responses from middle school teachers for descriptive statistical analysis. The sample includes 152 female teachers (56.5%) and 117 male teachers (43.5%), indicating a slightly higher proportion of female educators. In terms of age distribution, the largest group was teachers aged 26-35 (39.4%), followed by those aged 36-45 (28.3%). Educationally, the majority of participants held undergraduate degrees (67.3%), while only 14.9% had master's degrees or higher. Regarding computer proficiency, 39% reported an intermediate level, with smaller proportions indicating advanced skills (27.9%) or

beginner levels (10.8%). Teaching experience was relatively evenly distributed, with the highest proportions having 6-10 years (29%) or 11-20 years (28.2%) of experience.

### 4.2 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA), a crucial step in validating the measurement model, encompasses the assessment of model fit, convergent validity, and discriminant validity. It serves to verify whether the presupposed relationship between the observed variables and their underlying constructs is supported by the empirical data (Brown, 2015; Hair et al., 2019).

#### 4.2.1 Model Fit Indices for CFA

The confirmatory factor analysis demonstrated an excellent fit between the hypothesized measurement model and the observed data, as evidenced by the following key indices (see Table 2):

CMIN/DF = 1.074 (< 3), indicating a good fit (Kline, 2016).

RMSEA = 0.017 (< 0.05), indicating an excellent fit (Steiger, 1990).

SRMR = 0.040 (< 0.05), indicating an excellent fit (Hu & Bentler, 1999).

CFI = 0.991, TLI = 0.990, and IFI = 0.991 (all > 0.95), indicating excellent fit (Hu & Bentler, 1999).

The GFI value of 0.899 was slightly below 0.90 but is considered acceptable (> 0.85) when supported by other excellent indices (Schreiber et al., 2006).

All fit indices met or exceeded their respective acceptance thresholds, collectively affirming a strong model-data fit.

**Table 2:** Goodness of Fit for Measurement Model

Index	Criterion	Statistical Value
CMIN/DF	<3 (Kline, 2016)	1.074
RMSEA	<0.08 (Steiger, 1990)	0.017
GFI	>0.85 (Schreiber et al., 2006)	0.899
IFI	>0.9 (Hu & Bentler, 1999)	0.991
TLI	>0.9 (Hu & Bentler, 1999)	0.990
CFI	>0.9 (Hu & Bentler, 1999)	0.991
SRMR	<0.10 (Kline, 2005)	0.040

**Note:** CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, CFI = Comparative Fit Index, TLI = Tucker Lewis index, IFI = Incremental Fit Index, SRMR = Standardized root mean square residual and RMSEA = root mean square error of approximation

#### 4.2.2 Convergent Validity

Convergence validity is evaluated through Standardized Factor Loadings, Average Variance Extracted (AVE), and Composite Reliability (CR).

The standardized factor loading is usually required to be greater than 0.50, and the ideal standard is  $\geq 0.70$  (Hair et al., 2010).

CR  $\geq 0.70$  and AVE  $\geq 0.50$  are commonly used reference standards (Fornell & Larcker, 1981).

As shown in Table 3, the standardized factor loadings of each item are all above or close to 0.7. In addition, the average variance extraction (AVE) values of each variable have reached the required level of 0.5, and the combined reliability (CR) values are all above 0.7, indicating that the measurement model has sufficient convergence validity.

**Table 3:** Confirmatory Factor Analysis (CFA), Composite Reliability (CR), and Average Variance Extracted (AVE) Results

Variable	Source of Questionnaire (Measurement Indicator)	No. of Item	Cronbach's Alpha	Factor Loading	CR	AVE
Performance Expectancy(PE)	Venkatesh, et al. (2003)	8	0.914	0.729-0.799	0.914	0.571
Effort Expectancy(EE)	Venkatesh et al. (2003)	4	0.834	0.734-0.775	0.834	0.558
Social Influence(SI)	Venkatesh, et al. (2003)	4	0.821	0.647-0.779	0.826	0.543
Facilitating Conditions(FC)	Venkatesh et al. (2003)	4	0.834	0.699-0.797	0.835	0.559
Attitude(AT)	Davis (1989)	3	0.776	0.725-0.740	0.777	0.538
Behavioral Intention(BI)	Davis (1989)	3	0.817	0.722-0.819	0.817	0.599
TPACK ability(TPACK)	Schmidt et al. (2009)	4	0.843	0.714-0.776	0.844	0.575
Computer self-efficacy(CSE)	Compeau and Higgins (1995)	4	0.831	0.693-0.765	0.832	0.553

**Note:** CR = Composite Reliability, AVE = Average Variance Extracted

### 4.2.3 Discriminant Validity

The discriminant validity was evaluated using the Fornell Larcker criterion.

If the measurement model has discriminant validity, the square root of the AVE of any latent construct must be strictly greater than the absolute value of the correlation coefficient between that variable and all other latent constructs.

As shown in Table 4, the absolute value of the correlation coefficient between any two factors is less than the square root of the corresponding factor AVE, indicating a certain degree of discriminant validity between the factors.

**Table 4:** Discriminant Validity

Variable	Factor Correlations							
	PE	EE	SI	FC	AT	BI	TPACK	CSE
PE	.756							
EE	.517	.747						
SI	.391	.437	.737					
FC	.417	.495	.326	.748				
AT	.424	.463	.359	.364	.733			
BI	.551	.574	.496	.430	.546	.774		
TPACK	.419	.387	.295	.340	.350	.381	.758	
CSE	.383	.408	.376	.355	.307	.473	.291	.744

Note: The diagonally listed value is the AVE square roots of the variables

### 4.3 Structural Equation Modeling (SEM)

#### 4.3.1 Model Fit Indices for SEM

**Table 5:** Goodness of Fit for Structural Model

Index	Criterion	Statistical Value
CMIN/DF	<3 (Kline, 2016)	1.218
RMSEA	<0.08 (Steiger, 1990)	0.029
GFI	>0.85 (Schreiber et al., 2006)	0.885
IFI	>0.9 (Hu & Bentler, 1999)	0.975
TLI	>0.9 (Hu & Bentler, 1999)	0.972
CFI	>0.9 (Hu & Bentler, 1999)	0.974
SRMR	<0.10 (Kline, 2005)	0.088

Note: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, CFI = Comparative Fit Index, TLI = Tucker Lewis index, IFI = Incremental Fit Index, SRMR = Standardized root mean square residual and RMSEA = root mean square error of approximation

Table 5 shows the model fitting indices of the structural equation model (SEM). According to commonly used fitting standards, the fitting degree evaluation of the model in this study is as follows:

CMIN/DF = 1.218 (< 3), indicating a good fit (Kline, 2016).

RMSEA = 0.029 (< 0.05), indicating an excellent fit (Steiger, 1990).

IFI = 0.975, CFI = 0.974, TLI = 0.972 (all > 0.95), indicating excellent fit (Hu & Bentler, 1999).

SRMR = 0.088, which is below the liberal cutoff of 0.10 for acceptable fit (Kline, 2005), though slightly above the threshold of 0.08 for excellent fit.

The GFI value of 0.885 was slightly below 0.90 but is considered acceptable as it exceeds the 0.85 threshold (Schreiber et al., 2006).

The overall pattern of fit indices confirms that the model is acceptable and provides a good representation of the data structure.

#### 4.3.2 Research Hypothesis Testing Result

Path analysis was conducted using AMOS 26.0 to test the hypothesized relationships. The significance of each standardized path coefficient was assessed based on the critical ratio (C.R.) and its corresponding p-value (Kline, 2005). A path is considered statistically significant if the absolute value of C.R. ≥ 1.96 and p < 0.05, indicating support for the hypothesis. Only after confirming significance can the strength of the path effect be interpreted based on the coefficient values. The results are presented in Table 6.

**Table 6:** Hypothesis Testing Result

Hypothesis	Std Estimate	C.R.	P	Result
H1: PE → AT	0.299	3.662	***	supported
H2: PE → BI	0.214	3.356	***	supported
H3: EE → BI	0.249	2.939	0.003	supported
H4: SI → BI	0.192	2.74	0.006	supported
H5: FC → BI	0.025	0.348	0.728	not supported
H6: CSE → AT	0.192	2.556	0.011	supported
H7: CSE → BI	0.167	2.333	0.02	supported
H8: TPACK → AT	0.25	2.792	0.005	supported
H9: TPACK → PE	0.524	7.16	***	supported
H10: AT → BI	0.33	4.36	***	supported

Note: \*\*\* p < 0.001 , \*\* p < 0.01 , \* p < 0.05, C.R. = Critical Ratio, Std Estimate = Standardized Estimate

According to Table 7, TPACK capability has a strong positive impact on PE, with a standardized path coefficient of 0.524, P < 0.001;

PE, TPACK ability, and CSE all have a significant

positive impact on AT, with standardized path coefficients of 0.299, 0.25, and 0.192, respectively, and  $P < 0.05$ . The influence of PE is relatively prominent;

In the direct impact on behavioral intention, attitude has the most significant effect, with a standardized path coefficient of 0.33,  $P < 0.001$ ; Next are EE, PE, SI, and CSE, with standardized path coefficients of 0.249, 0.214, 0.192, and 0.167, respectively, all  $P < 0.05$ ; The effect of FC on BI is not significant, with a standardized path coefficient of 0.025,  $P = 0.728$ .

The results indicate that TPACK ability indirectly affects attitude and behavioral intention by influencing performance expectations. Attitude plays an important mediating role between multiple variables and behavioral intention, while computer self-efficacy has a direct positive impact on both attitude and behavioral intention.

**Table 7:** Intermediary effect test

path	Effect	Boot LLCI	Boot ULCI	P
PE→AT→BI	0.099	0.03	0.209	0.002
TPACK→AT→BI	0.082	0.022	0.178	0.005
CSE→AT→BI	0.063	0.013	0.136	0.017
TPACK→PE→AT	0.157	0.069	0.266	0.002
TPACK→PE→BI	0.112	0.027	0.224	0.007

**Note:** Boot LLCI = Bootstrap Lower Limit Confidence Interval, Boot ULCI = Bootstrap Upper Limit Confidence Interval

As shown in Table 7, the mediation effect test results indicate that all five pathways have significant mediation effects ( $P < 0.05$ , and the Bootstrap confidence intervals do not include 0).

Specifically, the indirect effect value of performance expectation (PE) on behavioral intention (BI) through attitude (AT) is 0.099; The TPACK ability not only affects behavioral intention through attitude (effect value 0.082), but also indirectly affects attitude and behavioral intention through performance expectations (effect values of 0.157 and 0.112, respectively), indicating the existence of multiple mediating pathways; The indirect effect value of computer self-efficacy (CSE) on behavioral intention through attitude is 0.063.

The results reveal that multiple independent variables not only have direct effects, but also form complex indirect influence mechanisms through mediating variables.

## 5. Conclusions and Recommendation

### 5.1 Conclusions

Based on a survey of 269 secondary school teachers in Huaibei, Anhui Province, this study examined key factors influencing their behavioural intention to use interactive whiteboards (IWBs) by integrating the UTAUT model with TPACK and computer self-efficacy constructs. The results demonstrated that attitude ( $\beta = 0.330$ ,  $p < 0.001$ ) was the strongest predictor of intention, underscoring the central role of affective evaluation in technology adoption. Performance expectancy ( $\beta = 0.313$ ) and effort expectancy ( $\beta = 0.249$ ) also had substantial total effects, indicating that perceived usefulness and ease of use remain crucial motivators. Computer self-efficacy ( $\beta = 0.230$ ) and TPACK capabilities ( $\beta = 0.194$ ) further contributed to intention, both directly and through mediating pathways, particularly via attitude. In contrast, social influence showed a relatively weak total effect ( $\beta = 0.192$ ), while facilitating conditions had no significant impact ( $\beta = 0.025$ ,  $p = 0.728$ ), suggesting that external support and infrastructure alone are insufficient to motivate use once a basic threshold is met.

These findings highlight that teachers' intention to use IWBs is primarily driven by intrinsic factors—attitudinal disposition, perceived utility, and self-belief in their capabilities—rather than external pressure or general resource provision. The insignificant role of facilitating conditions and modest impact of social influence reveal that current support systems may be misaligned with teachers' practical needs, overemphasizing hardware availability rather than pedagogical integration ability or emotional reassurance.

Therefore, to increase the willingness and sustained use level of interactive whiteboards, interventions should focus on fostering positive attitudes through discipline-specific exemplars and success cases, building technical and pedagogical competency via tiered training and mentoring, and aligning incentives with intrinsic motivations rather than compliance. Schools and policymakers should shift from emphasizing equipment provision to supporting teachers' autonomous integration of technology in ways that enhance teaching confidence and educational innovation.

### 5.2 Recommendations

This study found that the willingness of middle school teachers to use interactive whiteboards is not only influenced by the technology itself, but more importantly, by the synergistic effect between their value cognition, ability adaptation, and environmental support. Research has shown that teachers generally recognize the teaching auxiliary value of interactive whiteboards, but in practical

applications, there are problems such as "technical performance", value cognition differentiation between disciplines, cognitive contradictions between technology and teaching essence, and "supply-demand mismatch" in technical support. The improvement of hardware conditions has not significantly increased the willingness to use, while teachers are more concerned about resource applicability, technology integration teaching ability, and psychological experience.

Based on the above findings, this study suggests that policy design and training strategies should shift from "hardware driven" and "institutional pressure" to "teacher centered". Propose intervention strategies around the three dimensions of "value identification - ability support - environmental incentives", and the specific plan is as follows:

**Value recognition:** Strengthen the understanding of the effectiveness of technology teaching, visually demonstrate the role of technology in solving teaching problems through typical application cases (such as short videos and lesson plans), highlight the value of interactive whiteboards in enhancing effectiveness and student participation, and improve attitude and performance expectations.

**Ability support:** Reduce the threshold for use and make up for skill deficiencies. Provide subject preset templates and simplified operations to reduce cognitive load; Conduct layered training, including basic operation guidelines and advanced functional exploration activities; Establish subject technology mutual assistance groups, promote mentorship and themed seminars, and emphasize the development of TPACK capabilities that integrate technology, teaching methods, and subject content.

**Environmental incentives:** Promote sustainable use through institutional and resource support. Incorporate the effectiveness of technology integration into performance bonus points and innovation awards; Regularly update the high-quality case library; Establish a rapid response technical support mechanism to enhance promotion conditions and usage guarantees.

Through multidimensional collaborative intervention, promote the transformation of interactive whiteboards from "tool based use" to "teaching integration and innovation", and achieve a fundamental shift from external requirements to internal needs. Ultimately enhancing teachers' willingness to use.

### 5.3 Limitation and Further Study

Although this study reveals the key factors influencing teachers' use of interactive whiteboards, there are still certain limitations. Future research can further deepen and expand from the following four aspects:

Firstly, there are limitations to the representativeness of the sample. The current data comes from the teacher population in Huaibei City, Anhui Province, and its conclusions may be influenced by factors such as regional policies, school resources, and teacher technical literacy. Future research suggests expanding the sample coverage to include teacher groups with different levels of economic development or urban-rural differences, in order to verify the universality and applicability of the conclusions.

Secondly, there is a lack of vertical dynamic tracking. This study used a cross-sectional survey and failed to capture the dynamic evolution process of teachers' technology acceptance behavior. It is recommended to introduce longitudinal research designs in the future, such as conducting surveys at multiple time points such as the initial stage of technology introduction, one semester later, and one academic year later, in order to evaluate the normalization level of technology application and identify long-term driving or hindering factors.

Thirdly, the theoretical model needs to be further optimized, especially by deepening the exploration of "promoting conditions". This study did not find a significant impact of promoting conditions on behavioral intention, which may be related to measurement bias or situational interference. In the future, the measurement dimension of this variable should be improved and situational variables such as disciplinary differences should be included to more accurately formulate differentiated technical support strategies.

Fourth, strengthen the integration and complementarity of qualitative research and quantitative results. In the future, qualitative methods such as interviews can be introduced to deeply explore the motivations, dilemmas, and emotional experiences of teachers in the application of technology, thereby forming a more in-depth explanation and supplement to quantitative results.

These suggestions not only address the existing limitations of this study, but also expand its theoretical depth and practical value. Subsequent research should focus on longitudinal tracking, disciplinary heterogeneity, and method integration, deepening the understanding of educational technology integration from both dynamic and situational dimensions, while enhancing the application guidance significance of the results.

## References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Bandura, A. (1977). *Self-efficacy: The exercise of control*. W.H. Freeman.
- Brown, T. A. (2015). *Confirmatory factor analysis for applied research* (2nd ed.). Guilford Press.
- Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211. <https://doi.org/10.2307/249688>
- Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2013). A review of technological pedagogical content knowledge. *Educational Technology & Society*, 16(2), 31-51. <https://www.jstor.org/stable/jeductechsoci.16.2.31>
- Chen, X., & Liu, T. (2020). Teacher professional development in information technology: A case study of Guangzhou Electromechanical Technician College. *Technology Wind*, 32, 78-80.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340. <https://doi.org/10.2307/249008>
- Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2017). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers*, 21(3), 719-734. <https://doi.org/10.1007/s10796-017-9774-y>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50. <https://doi.org/10.1177/002224378101800104>
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1-55. <https://doi.org/10.1080/10705519909540118>
- Higgins, S., Beauchamp, G., & Miller, D. (2007). Reviewing the literature on interactive whiteboards. *Learning, Media and Technology*, 32(3), 213-225. <https://doi.org/10.1080/17439880701511040>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Prentice Hall.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). Guilford Press.
- Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage Publications.
- Niu, C. X. (2018). *Research on factors influencing junior high school teachers' intention to adopt technology* [Master's thesis]. Northeast Normal University.
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
- Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research*, 25(2), 173-180. [https://doi.org/10.1207/s15327906mbr2502\\_4](https://doi.org/10.1207/s15327906mbr2502_4)
- Schreiber, J. B., Stage, F. K., King, J., Nora, A., & Barlow, E. A. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, 99(6), 323-338. <https://doi.org/10.3200/JOER.99.6.323-338>
- Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, 42(2), 123-149. <https://doi.org/10.1080/15391523.2009.10782544>
- Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education*, 128, 13-35. <https://doi.org/10.1016/j.compedu.2018.09.009>
- Torkzadeh, G., & Doll, W. J. (1988). The test-retest reliability of user involvement instruments. *Information & Management*, 14(4), 185-193. [https://doi.org/10.1016/0378-7206\(88\)90057-8](https://doi.org/10.1016/0378-7206(88)90057-8)
- Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education*, 52(2), 302-312. <https://doi.org/10.1016/j.compedu.2008.08.006>
- Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education*, 57(4), 2432-2440. <https://doi.org/10.1016/j.compedu.2011.06.008>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478. <https://doi.org/10.2307/30036540>
- Venkatesh, V., Brown, S. A., Maruping, L. M., & Bala, H. (2008). Predicting different conceptualizations of system use: The competing roles of behavioral intention, facilitating conditions, and behavioral expectation. *MIS Quarterly*, 32(3), 483-502. <https://doi.org/10.2307/25148853>
- Zhang, Z. (2016). *Research on factors influencing pre-service teachers' adoption of technology in teaching* [Doctoral dissertation]. Northeast Normal University.