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Extending the TAM model to explore the factors that affect Intention to Use digital textbooks in primary teachers' views*

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Abstract. The main purpose of this study was to investigate the views of the primary teachers' future intention to use digital textbooks. In this paper, we take the Technology Acceptance as a foundation and extend the external variables including satisfaction usefulness, interactive learning activities, digital textbook effectiveness and user-interface design. Data was collected through questionnaire from 220 schools in some Chinese province; research is designed as structural equation modelling to analyze the key factors which influence teachers to use digital textbooks that is a new way of digital learning. This paper proposes a number of scientific hypotheses and validates the extending model. Results show that most of hypotheses are supported, which indicate that the extended variables are important factors to make a multi-level influence on teachers. Finally it is inferred that a conceptual model which is accepted easily by teachers, for understanding teachers' satisfaction, effectiveness and intention of digital textbooks and developing or designing the digital textbooks.

Keywords. Technology acceptance model, digital textbooks, interactive learning activities, user-interface design, structural equation model

Introduction

For many decades, with the popularization of all kinds of learning facilities, such as electronic textbooks, tablets, mobile learning terminals [1]. Electronic textbooks as one of new media and information technology, gradually come into the classroom. Digital textbooks, also known as digital textbooks, are a kind of e-books or electronic books, which follow the rules of learning and read, are beneficial to organize learning activities, conform to the course objectives and are orchestrated according to the style of books [2] (Chen Guang, Gong Chaohua &Huang Ronghuai, 2012).The essence of promotion and use of digital textbooks at school is the promotion of new technology and the innovation of education concept. With the development of network technology and modern information technology, education technology also has a very big change. Teachers no longer rely on the traditional education means and resources such as chalk, blackboard , but occupy most in the field of Educational Technology and take on the role of engaging in teaching and learning by using technology effectively. Furthermore teachers are the important practitioners who integrate technology in the teaching of the

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education. They are also the operators who rein the digital textbooks in actual classroom teaching. However, the existing teaching mode and the concept are difficult to meet the demand of digital textbooks teaching. The case of using e-textbooks in practical teaching activities is in a bad way. Based on technology acceptance model, it is significant to gradually analyzing teachers' willingness to behavior such as new technology and building usage model of new technology.

Based on the extending TAM[3], this paper increases external variables, such as the interactive learning behavior, interactive interface design and satisfaction etc. In this study, we make use of digital textbooks for English teachers in primary schools, explain and predict teachers' behavior willingness to accept digital textbooks.

1. Research Model and Hypotheses

TAM[4][5] was proposed by Davis etc. in 1989, the model suggested that technology acceptance is mediated by two individual beliefs: perceived ease of use (PEOU) and perceived usefulness (PU). The actual usage is determined by behavioral intention (BI), perceived ease of use and attitudes influence behavioral intention, external variables affect intention and usage[6]. Moreover, study found external variables can strengthen acceptance for the technology acceptance model in the new technology system ,predict the ability of the and willingness. Venkatesh and Davis (2000) proposed TAM2[7], refined further external variables. In this study, we retain PU, PEOU, BI and attitudes, extending satisfaction usefulness, interactive learning activities, digital textbook effectiveness and user-interface design. Based on this, we propose the following hypotheses **Figure 1.**

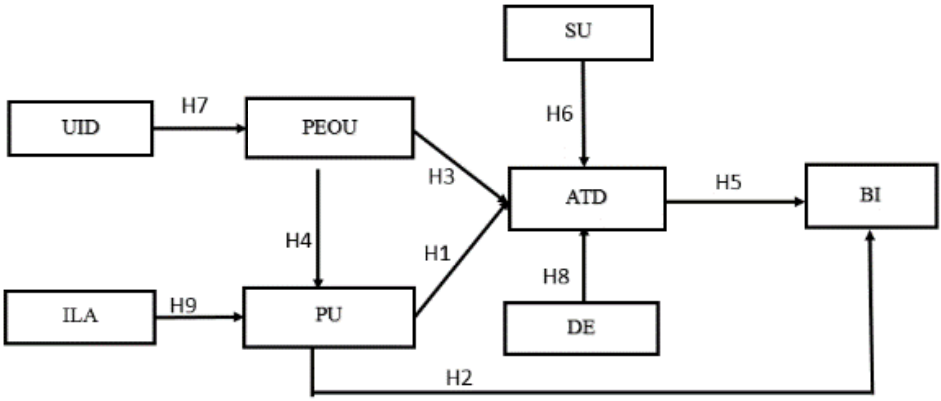

Figure 1. The Extending TAM model frame

- Perceived usefulness

Perceived usefulness is defined people believes the system or technology can help perform in study and job [3]. In this paper, we define perceived usefulness as cognition level which teachers perceived the improving of teaching effectiveness by digital

textbooks, in other words, they believe digital textbooks will help to achieve teaching goal, improve students' effectiveness. Further, the more benefits they receive, the more active they will be to use. This leads to the following hypotheses:

H1: Perceived usefulness has a positive effect on attitudes towards the digital textbooks.

H2: Perceived usefulness has a positive effect on behavioral intention.

- Perceived Ease of Use

Perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort [3]. In this paper, we define Perceived ease of use as easy level which teachers feel comfortable while using digital textbooks. Namely, they don't need more energy to handle. Therefore, we hypothesize:

H3: Perceived ease of use has a positive effect on attitudes towards the digital textbooks.

The existence of causation has been confirmed by many empirical studies (Davis, 1989, 1993).As the following hypotheses:

H4: Perceived ease of use has a positive effect on perceived usefulness.

- Attitude towards digital textbooks

Attitude is defined here as whether or not individuals like behavioral objectives[8]. In this paper, attitude towards digital textbooks means teachers' positive or negative feelings subjectively when they use digital textbooks. Perceived ease of use and perceived usefulness all affect attitude, several studies have already proved attitude influence behavioral intention[9]. We propose the following hypotheses.

H5: Attitude towards digital textbooks has a positive effect on behavioral intention.

- Satisfaction usefulness

Satisfaction usefulness is defined that teachers whether or not satisfy with functions and contents of the digital textbooks in this paper, furthermore affect the users' affection and positivity. We propose hypotheses:

H6: Satisfaction usefulness has a positive effect on attitudes towards the digital textbooks.

- Interactive learning activities

Interactive learning activities is defined as exchange or share experience. Essentially, if users are lack of interaction, that means they have less self-confidence. They will show less interest towards technology, therefore, they will consider it useless[10]. We propose hypotheses:

H7: Interactive learning activities has a positive effect on perceived usefulness.

- Digital textbook effectiveness

Effectiveness means whether digital textbooks are effective. Studies have suggested that: higher interactivity can lead to higher learner engagement and better learning outcome (Northrup, 2001)[11]. We propose hypotheses:

H9: Digital textbook effectiveness has a positive effect on attitudes towards the digital textbooks.

- User-interface design

User-interface design means display mode and patter of digital textbooks' content and multimedia resource. The user-interface design will not facilitate better easy operation if it does not meet users' needs. We propose hypotheses:

H9: User-interface design has a positive effect on perceived ease of use.

- Behavioral intention

Behavioral intention was proposed by Davis (1989), whether or not user intend to use technology. We extend to the intention of using continuously, which means teachers want to use persistently.

2. Research Methodology

The research method used in our study is a questionnaire survey. The design of questionnaire references a flood of literatures and we translate them according to the Chinese language habits. We draw on the views of teachers and researchers by interviews and revising these questionnaires according to the actual environment. Questions were answered using all 7-point (ranging from 1 which means "strongly disagree" to 7 which means "strongly agree") in **Table 1.**

Table 1. List of constructs and corresponding item

Factor	Sample Item	Reference
PU	PU1 Digital textbook enables me to accomplish tasks more quickly. PU2 Using digital textbook improves my job performance. PU3 Using digital textbook enhances my effectiveness on the job.	Fred D. Davis(1993)
PEOU	PEOU1 Interacting with the Digital textbook is often frustrating PEOU2 I find it easy to get the Digital textbook to do what I want it to do. PEOU3 My interaction with the Digital textbook is clear and understandable.	Fred D. Davis(1993)
ATD	AT1 Using Digital textbook is a good idea AT2 Using Digital textbook is a wise idea.	Davis(1989); Moon J, Kim Y(2001)
SU	SU1 The Digital textbook provide useful content. SU2 I am satisfied with using Digital textbook functions.	Yi-Shun Wang(2003)
ILA	ILA1 I would like to share my Digital textbook experience. ILA2 I believe Digital textbook can assist teacher-learner interaction	Liu I F, Chen M C, Sun Y S, et al(2010)
DE	PE1 I believe Digital textbook can assist learning performance.	Yi-Shun Wang(2003)
UID	UID1 The layout design of the Digital textbook makes it easy to read.	Yi-Shun Wang(2003)
BI	BI1 I intend to use Digital textbook to assit my learning.	Yi-Shun Wang(2003)

The respondents of this paper are English teachers who are from more than 200 primary schools of 6 regions of a province in China. These regions covers the urban area, towns and rural areas. The data for this study were gathered by means of questionnaire platform in Web, lasting 4 weeks. Therefore, of this study group comprised 507 teachers.

3. Data Analyses

3.1. Reliability Analysis

This research mainly checks the internal consistency reliability of questionnaires. We use Cronbach's alpha to measure it. Used by SPSS18.0 software, each variable's value is greater than 0.7 and achieves the high reliability index.

3.2. Validity Analysis

The questionnaire is designed primarily refer to the relevant literatures whose questionnaires have been quite mature. Some variables are basically quoted, and therefore it has a good degree of content validity. This paper adopts Exploratory Factor Analysis (EFA) to analyze and uses the method of principal component analysis to check the construct validity of the questionnaire. If the value of KMO is greater than 0.5, it is suitable for doing factor analysis, reference component matrix and cumulative. The questionnaire has a good factor structure in **Table 2.**

Table 2. Convergent and validities

	KMO	**Bartlett's test of sphericity**			**Component matrix**		**Cumulative**
		x2	***DF***	***Sig***			
PU	0.912	1452.639	10	0.000	PU1	0.936	86.937%
					PU2	0.945	
					PU3	0.926	
					PU4	0.920	
					PU5	0.935	
PEOU	0.768	585.222	10	0.000	PEOU1	0.638	59.668%
					PEOU2	0.913	
					PEOU3	0.842	
					PEOU4	0.799	
					PEOU5	0.863	
ATD	0.736	677.097	3	0.000	AT1	0.947	88.497%
					AT2	0.961	
					AT3	0.913	
SU	0.821	765.242	6	0.000	SU1	0.911	80.478%
					SU2	0.909	
					SU3	0.921	
					SU4	0.846	
ILA	0.709	614.396	3	0.000	ILA1	0.870	85.344%
					ILA2	0.950	
					ILA3	0.949	
DE	0.775	773.703	3	0.000	PE1	0.952	91.522%
					PE2	0.962	
					PE3	0.957	
UID	0.500	183.549	1	0.000	UID1	0.928	86.182%
					UID2	0.928	
BI	0.684	464.100	3	0.000	BI1	0.921	80.425%
					BI2	0.938	
					BI3	0.827	

- the People Characteristics of Sample Analysis

The sample characteristics are presented which shows that 78.7% of those sampled were women, and 21.3% men. Although in the survey the number of female teachers is more than the number of male teachers, but it almost meets the current sex ratio of primary school teachers [14] in **Table 3.**

Table 3. People Characteristics

People Characteristics		frequency	%
age	<25	51	10.1
	26-30	140	27.6
	31-35	103	20.3
	36-40	78	15.4
	>40	135	26.6
Teaching experience	<2 years	68	13.4
	2-5 years	100	19.7
	6-10 years	47	9.3
	>10years	292	57.6
Educational background	under Specialty	7	1.4
	Specialty	93	18.3
	undergraduate	389	76.7
	Beyond Postgraduate	18	3.6
grade	1	59	3.6
	2	122	2.4
	3	135	30.6
	4	18	23.7
	5	36	23.3
	6	137	16.6
How long to use	never	59	11.6
	Less than one month	122	24.1
	1-3 monthes	135	26.6
	One term	18	3.6
	One year	36	7.1
	others	137	27.0
How often to use	Every classes	231	45.6
	Some classes	192	37.9
	Once in every term	84	16.6

- SEM Analysis

Through the above analysis, the descriptive analysis, reliability and validity testing has been completed. The analysis results show that the questionnaire and collected data in this research have a high degree of reliability and validity. Therefore, the AMOS 17.0 software was used for the SEM analysis structural equation modeling (SEM). SEM is a statistical approach for examining the causal relationships and testing the hypotheses. Maximum Likelihood (ML) is one of Common methods to analysis SEM.

4. Discussion

The parameters estimates for both samples are shown in **Table 4.**, CMIN/DF=0.567, CFI=1.000, RMSEA=0.000. The entire model presents a good fit[15], which means the collected data matches the research model.

Table 4. Statistics of model fit measures

Model fit measure	P	CMIN/DF	GFI	AGFI	NFI	CFI	RMSEA
Model value	P>0.05	<3	>0.9	>0.9	>0.9	>0.9	<0.1
Recommended value	0.636	0.567	0.999	0.990	1.000	1.000	0.000

In addition to the factors in TAM, new factors (satisfaction usefulness, interactive learning activities, digital textbook effectiveness and user-interface design) have been verified, further, revised the extending model. User-interface design has a positive effect on perceived usefulness (β=1.30, p<0.001) and behavioral intention (β=0.49, p<0.001). Hence, hypotheses H7 were supported. In other words, Simple and reasonable digital textbook interface design and layout directly affect willing and operation. The more friendly and ideal interface design, the more they want to use. Interactive learning activities has a positive effect on perceived usefulness (β=0.91, p<0.001) and attitudes (β=0.20, p<0.001). Hypotheses H9 were also supported. Richer and positive interaction they have, the more intense attitudes. Satisfaction has a positive impact on attitudes (β=0.33, p<0.001), Hypotheses H6 also were supported. If teachers satisfied with digital textbooks, they will have vivid intention to use it.

Digital textbook effectiveness has not a positive impact on attitudes (p=0.145), but has an effect on behavioral intention (β=0.04, p<0.001). The results of testing the structural model are presented in **Figure 2.**

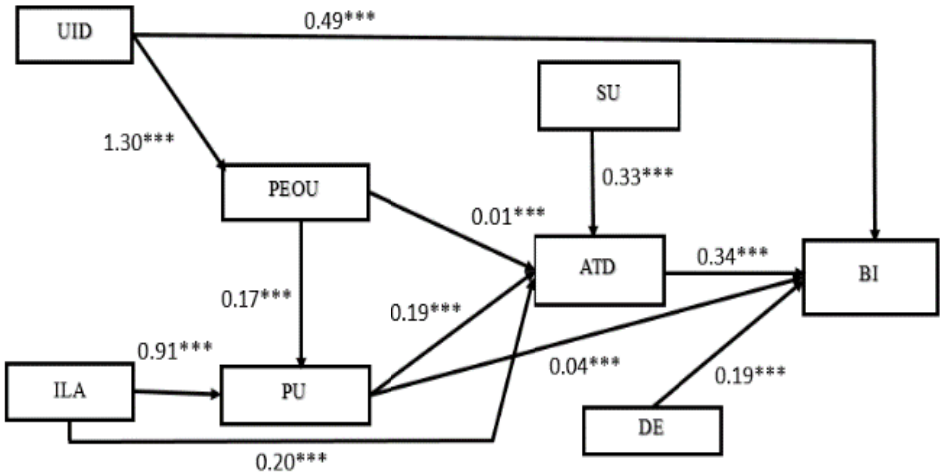

Figure 2. The Extending TAM mode's test results

This study has investigated the underlying relationship between satisfaction usefulness, interactive learning activities, digital textbook effectiveness and user-interface design, hypotheses are shown in **Table 5.**

Table 5. Hypothesis testing Conclusion

	Path	P	result
H1	PU->ATD	***	yes
H2	PU->BI	***	yes
H3	PEOU->ATD	***	yes
H4	PEOU->PU	***	yes
H5	ATD->BI	***	yes
H6	SU->AT	***	yes
H7	ILA->PU	***	yes
H8	EE->ATD	0.145	no
H9	UID>PEOU	***	yes

5. Conclusion

The result shows that perceived Ease of Use, perceived usefulness and satisfaction usefulness have a direct impact on attitude towards digital textbook by SEM analysis, and thus indirectly influence behavioral intentions; Interface design and the effectiveness of digital textbook learning directly impact on behavioral intentions; Interactive learning behavior indirectly affects usage behavior by perceived usefulness, and further amends and supplements the factors' relationship of the model.

- Interface design has a positive impact on teachers' behavioral intention to accept the digital textbooks

The user directly know teaching content of digital textbooks, media resources and functions operation through the Interface firstly. Related studies (Rovai, 2004) also confirm that interface design is an important factor affecting the perceived ease of use[16]. When the interface is more user-friendly and the operation more easily, users feel more comfortable and relaxed. The conclusion is similar with previous studies[17] [18] (Jones et al, 1995; Martin-Michiellot & Mendelsohn, 2000). They show that the interface layout and display pattern will affect the will of use of digital reading materials. Therefore, the diversification should be considered when designing and developing interface to meet users' operation processes, etc.

- Interactive learning behavior has multi-level positive impact on behavior intention whit digital textbooks

Interaction and exchange of rich diversity of digital teaching platform can make teachers will to share experience and use it to teach. Therefore, we suggest we make a "Friends circle" of teachers and teaching to increase the communication between teachers. The designs and developments of digital textbook increase interaction with encourage between teachers and students and form the good study atmosphere.

- Satisfaction has indirect influences on behavior intention to accept books.

In order to meet the different levels of users, we suggest that developing and designing the requirements meet the users' characteristic, such as practical teaching environment or school geographical features.

- The effectiveness of learning has a directly influence on behavior intention.

The effective cognitive that whether teachers hold the view that digital textbook can improve students' academic performance and enhance the enthusiasm of teaching cognitive influences the use of digital textbook. In other words, the more perfect and abundant functions or contents are, the more positive the digital textbook promotes the

teaching efficiency. Teachers will have greater motivation and interest to use digital textbooks.

In conclusion, satisfaction degree of digital textbook with interface design, interactive elements, textbooks' contents and media resources will affect the teachers' intention. Then we can predict that if the design and development of digital textbooks meet the above factors, users' intentions will become more obvious.

6. Limitations

This study has several limitations. Firstly, the lack of derails about how limiting or not use of digital textbooks is to the teaching itself; teacher training opportunities to use digital textbooks efficiently; Secondly, TAM factors should also be extended to collect and analyze data from different schools' backgrounds, geographical distribution, which is under the present study a need to study and analyze the phase content.

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