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Rural teachers' acceptance of interactive white board-based ICT in Taiwan

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ABSTRACT: In order to understand the realistic use and impact of interactive white boards (IWB) on ICT in Taiwan, a survey was used to gather information on teachers' perceptions. The technology acceptance model was used as the theoretical basis in this study. Collected data were analysed using the structural equation modelling technique (SEM). A total of 335 questionnaires were retrieved from 114 rural schools, a return rate of 62.28%. The confirmatory factor analysis (CFA) test by SEM showed a satisfactory model fit to the hypothetical model. Important results were: 1) Perceived ease of use (PEU) has a positive and direct impact on perceived usefulness (PU), indicating that IWB are favoured by teachers and encounters zero resistance; 2) PEU and PU both have a positive and direct impact on behavioural intentions to use (BI), indirectly suggesting that greater convenience and practicability of IWB can increase teachers' intention to use IWB; and 3) Behavioural intention to use IWB has a direct impact on actual system use, which demonstrates that IWB-based teaching environments already have been widely integrated by teachers into their teaching methods.

Keywords: Rural teachers, interactive white board, technology acceptance model, structural equation modelling

INTRODUCTION

In this age of information and communication technology (ICT), digital products have become an indispensable part of individuals' daily lives, learning, work and entertainment. The impact has transformed communication from one-way to multi-dimensional in which users become information participants or providers rather than passive receivers. In view of this, a new digital learning ecology has gradually developed. One urgent task for educational authorities in all nations is to improve students' learning ability through the utilisation of digital methods. Taiwan's Ministry of Education had recognised global ICT trends in the 1980s. The *General Guidelines of Grade 1-9 Curriculum of Elementary and Junior High School Education*, published in 2001, clearly states that ICT education should be incorporated into all curricula, demanding specifically that students should have the ability of *knowing* and *doing*, while teachers should fully apply ICT to more than 20% of teaching activities [1][2].

In addition, the Ministry of Education and the National Science Council have been vigorously promoting the ICT integrated teaching plan since 2007, the major purposes of which are to assist teachers in acquiring various digital teaching materials and to synthesise and construct data into an integrated platform of teaching resources that can serve as a share and exchange mechanism. In the earliest phase, the basic construction of different information platforms was accomplished (Internet, information equipment, free software and electronic classrooms). In the second phase, a digital information centre was established. Teaching and promotion were integrated in the third phase, and systems and regulations in the fourth phase. In the fifth phase, teacher training and ability indicators were accomplished. The final phase was the development of students' information literacy and ability [3].

According to the White Paper on IT in K-12 Education, teacher information outlines were included into teaching action plans. Teachers are expected to satisfy the National Educational Technology Standards for Teacher (NETS for teachers, NETS•T) [3]. In the meantime, the Taiwanese Government has budgeted for the renewal of computer facilities in elementary and middle schools in all cities and counties, as well as subsidising schools to establish *e-learning: interactive white boards* (IWB*) classrooms* [4]. As IWB teaching systems are only in the beginning stage, teachers' habits of use and teaching efficacy need to be evaluated over time. If IWB-based e-learning activities are to be comprehensively integrated, a few issues need to be considered. The first needs to address the digital divide. The other is to introduce a student-oriented digital learning environment. Finally, teachers' intentions and learning efficacy should be evaluated [5][6]. The Public Broadcasting Service (PBS) survey showed that a relatively lower proportion of teachers use technological media in teaching, which seemed to be at odds with contemporary learning models [7].

An improvement in this situation requires teachers' acceptance and execution of ICT [8-10]. In particular, modern teachers enable and facilitate learning and, therefore, how teachers handle newly developed educational technology and lead students to the next generation of learning is critical.

Pingtung County in Taiwan, which is located in the southernmost part of Taiwan, was chosen in this study as the research location. Because of its remote location and lack of educational resources, the county must receive yearly sponsorship from the educational priority area (EPA) project. Based on this, and another project that creates digital opportunities for rural areas, since 2009, the Pingtung Government has subsidised all rural schools to establish multi-functional digital classrooms, and has purchased one to three sets of IWB-related facilities for each school in order to reduce the digital divide. When the facilities arrived, each school organised relevant workshops and teaching demonstrations, expecting to improve behavioural use intention (intention to use IWB) and teaching efficacy. Accordingly, this study seeks to understand teachers' attitude towards behavioural intention to use, and actual systematic use of, an IWB-based ICT teaching environment, so as to serve as a reference for the future promotion of such systems.

LITERATURE REVIEW

Teaching Environment in the ICT Age

Information and Communications Technology has become a developmental focus of education reform worldwide. As users' behavioural intention and actual use of computers have significantly increased, differences between the information rich and the information poor still exist [11]. A study by the National Telecommunications and Information Administration in the US suggested that the digital divide has become an indisputable fact [12]. The Organisation for Economic Co-operation and Development (OECD) pointed out in the book *Understanding the Digital Divide* that the reasons contributing to this phenomenon are many and varied, including internal factors and external environmental factors [13]. Many studies have examined the conditions causing the digital divide. For instance, the International Labour Organisation (ILO) and OECD both proposed that gender, age, ethnicity, language, education and location are all associated with the digital divide [14].

An external digital environment requires usage opportunities, content access, technological literacy and community [15]. To solve the aforementioned problems requires a combination of efforts from different parties. Governments, as forces of reform, should design related policies and provide long-term support for the ICT education industry, so that minority groups do not suffer double social exclusion [16]. Corporations and enterprises should serve as system developers, providing diverse and appropriate digital facilities, fulfilling their social responsibilities. Education authorities should serve as promoters responsible for budgeting and educational training, as well as for a digital paradigm shift. Front-line teachers are the executors of this paradigm shift and should not only pay attention to current development opportunities in ICT, but also realise that digital learning has become an indispensable part of teaching [17][18].

Teachers cannot oppose this change; instead, they should enhance their own information literacy. They should combine personal educational expertise and knowledge to analyse, design, develop, practise and evaluate the construction of a systematic teaching model, transforming curricula and teaching materials into digital formats and evaluating learning efficacy [19]. Although early studies disputed the learning efficacy of digital media, without a doubt, digital teaching has become deeply rooted in education [20-25]. Studies have pointed out that the key factor in the promotion of ICT lies in the guidance to curricula and teaching, rather than the technology itself [26]. If teachers fail to fully utilise the advantages of ICT, the value of electronic learning is naturally reduced.

If teachers adopt more ICT content in their interactions with students, learning interest and efficacy will show a healthy improvement. The main factor that hinders teachers is that an ICT teaching platform involves changes in the interactive environment. A study by Gilbert and Moore pointed out that a dynamic interactive teaching model has an impact on learning efficacy, especially on higher levels of cognitive learning [27].

Particularly in recent years, as ICT-related facilities have been upgraded, teachers have gradually given up the conventional chalk and blackboard approach and adopted digital materials instead. Projectors and Web platforms have provided a more efficient teaching model [28]. Promotion and utilisation of an IWB-based ICT teaching platform has also been helped by an upsurge in educational technology in recent years. A research group from Keele University in Great Britain has developed teaching resources and software for IWB, and has offered the results to elementary and middle school teachers for free use and sharing [29]. A further related study confirmed that when IWB is used in teaching, students may actively acquire ICT knowledge and skills, hence improving their ICT literacy without their noticing [30].

The DCSF Primary Schools Whiteboard Expansion Project found that the long-term use of IWB can effectively improve students' learning efficacy, no matter whether in mathematics, science or English composition [31]. Another study indicated that schools should consider three key factors when introducing IWB: technical support, teachers' expertise and behavioural intention to use [32]. Relevant studies have shown that teachers' behavioural intention to use and ability to develop an IWB system form an invisible wall hindering improvements in teaching [33][34].

Most IWB-based electronic classrooms currently promoted in Taiwan are designed and provided by manufacturers. Therefore, teachers are less familiar with the use of this environment and with the software and hardware. Hence, appropriate teaching concepts and habits need to be cultivated. At the same time, there is a lack of empirical studies of teaching efficacy, which is an obstacle to an increase in usage among elementary and middle school teachers. To sum up, a good ICT teaching platform requires more than just purchasing software and hardware. The electronic system should not just be impressive in appearance. What is really needed is the combination of teachers' self-awareness and action. This study particularly focused on whether rural teachers can understand the distinction between feasibility, perceived ease of use and practicability of an innovative teaching platform through a process of self-evaluation. Understanding of these distinctions is considered the key factor in the success, or otherwise, of an ICT integrated teaching plan.

Technology Acceptance Model (TAM)

The technology acceptance model (TAM) was used to examine the relation between perceptional and affectional factors in the use of information technology facilities based on the theory of reasoned action (TRA) [35][36]. The major objective of this model is to explain users' acceptance and adoption of information technology in terms of users' internally perceived viewpoints. In other words, this model is used to understand more about the impact of external factors on users' internal attitudes, beliefs and intentions, and also on users' use of technology [37]. As a result, TAM is an oft-applied theory in studies on user acceptance of technology [38]. When applying TAM, several basic assumptions need to be made [39], as follows:

1. The two most important concepts affecting individuals' attitudes towards uses of new technologies are: perceived usefulness (PU) and perceived ease of use (PEU). In 1989, Davis defined PU as the objectively expected probability of work or learning performance being improved by the use of a specific system; PEU refers to the ease in using the system. In other words, if a user considers a system to have a higher level of PEU, it is more likely to impact the PU [40].
2. If individuals consider information technology easy to use and useful for their work, it impacts not only on their behavioural intention to use (BI) but also directly on their actual system use (AU).
3. When potential users possess more positive attitudes towards a new technology, they will have a stronger behavioural intention to use it. Similarly, when users' behavioural intention to use is stronger, their actual system use is assumed to be more significant.

RESEARCH METHOD

This study conducted a questionnaire survey to understand elementary and middle school teachers' acceptance of an IWB-based ICT teaching platform. The hypothetical model was established based on TAM. The question items were adapted from Davis and constructed according to PU, PEU, BI and AU [40]. A Likert seven point scale was used, ranging from highly agree to highly disagree. The research subjects for the general survey were seed teachers who have completed educational training and were from 114 rural regional elementary and middle schools with ICT classrooms in Pingtung County.

A total number of 570 copies of questionnaire were distributed, and 355 valid samples were collected (62.28 %). As it was intended to analyse a hypothetical mode, traditional factor analysis could not effectively and comprehensively examine the structural relation (casual relation) between factors (latent variables) [41]. Therefore, the structural equation modelling (SEM) method was adopted. The statistical software SPSS 17.0 and AMOS 17.0 were the analytical tools used in this study. The SEM analysis procedure was: 1) examine, if the hypothetical model is accepted by confirmatory factor analysis (CFA); 2) examine the latent relation and model fit of SEM; and 3) conduct path analysis. According to the TAM theory, PEU should have an impact on PU, and have a further impact on BI and AU. The research structure is presented in Figure 1, and Table 1 shows the research hypotheses.

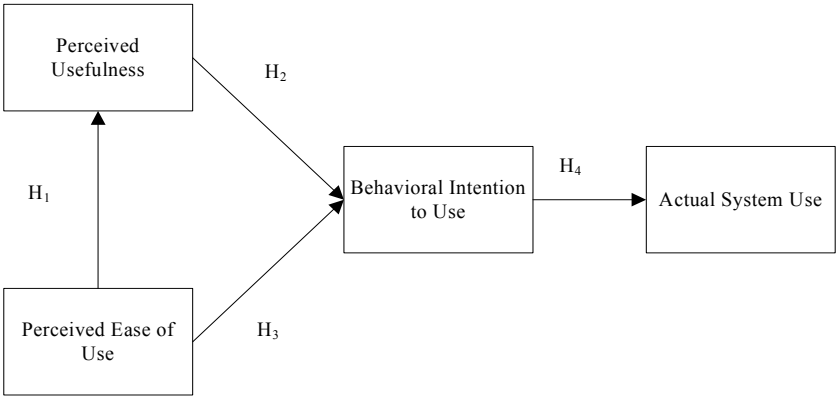

Figure 1: Research framework.

Table 1: Research hypotheses.

Hypothesis	Content
Hypothesis 1	PEU has a positive impact on perceived usefulness PU.
Hypothesis 2	PU has a positive impact on BI.
Hypothesis 3	PEU has a positive impact on BI.
Hypothesis 4	BI has a positive impact on AU.

ANALYTICAL RESULTS

The descriptive statistics show that respondents all have a high level of acceptance of IWB-based ICT teaching environments, with an average score between 4.85 and 5.17. The highest score is BI, while AU is the lowest. In order to present the measure effects between latent variables and observed variables, as well as the casual relation between latent variables, this study verified the hypothetical model using SEM, a process which involved two parts.

Confirmatory Factor Analysis (CFA)

This study used confirmatory factor analysis to examine the co-variance relation between the observed variables and latent variables, as well as calculating the convergent and discrimination validity of the CFA-measured model, as shown in Table 2. Confirmatory factor analysis shows that the factor loading of estimated parameters of all observed variables is larger than 0.45, with its multiple correlation square value larger than 0.2, indicating convergent validity [42][43]. The model also satisfies the standard of discrimination validity, with each value between 0.78 and 0.81. The standard was determined by the AVE root square value of each aspect being larger than 75% of the loading of the correlation coefficient of each aspect [44]. The composite reliability (CR) of this study was between 0.83, and 0.86 and its average variance extracted (AVE) was between 0.61 and 0.66, both larger than the suggested values of 0.6 and 0.5 [45]. The aforementioned figures show that all the observed variables in this research structure can reflect the constructed latent variables.

Table 2: Confirmatory factor analysis of the model.

Observed Variables	M	SD	SK	KU	SFL	SMC	EV	CR	AVE
Perceived Usefulness	5.000							0.86	0.61
instruction improvement	5.044	1.169	0.050	-0.570	0.86*	0.74	0.74*		
instruction performance	5.196	1.202	-0.048	-0.698	0.82*	0.67	0.66*		
instruction efficiency	4.554	1.467	-0.066	-0.791	0.73*	0.53	0.53*		
instruction effective	5.211	1.174	0.031	-0.779	0.86*	0.74	0.73*		
Perceived Ease of Use	5.000							0.85	0.66
learning easily	5.162	1.139	-0.104	-0.425	0.87*	0.76	0.75*		
understanding easily	5.026	1.173	-0.058	-0.458	0.85*	0.72	0.72*		
presenting easily	4.823	1.305	-0.100	-0.533	0.75*	0.56	0.57*		
Behaviour Intention	5.167							0.84	0.63
try to use	4.773	1.349	0.199	-0.775	0.73*	0.53	0.54*		
need to use	5.513	1.125	-0.297	-0.221	0.74*	0.55	0.54*		
like to use	5.217	1.183	-0.207	-0.249	0.51*	0.26	0.27*		
Actual Usage	4.845							0.83	0.62
use anywhere frequently	5.187	1.277	-0.333	-0.465	0.76*	0.58	0.58*		
use anyhow possibly	4.528	1.401	0.081	-0.804	0.85*	0.72	0.72*		
use appropriately	4.820	1.421	-0.224	-0.698	0.74*	0.58	0.55*		

Note: *p<0.05; *M*: mean; *SD*: standard deviation, *SK*: skewed, *KU*: Kurtosis, *SFL*: standardised factor loading, *SMC*: square multiple correlation, *EV*: error variance, *CR*: composite reliability, *AV*E: average of variance extracted

Overall Model Fit

The research model comprised four aspects, and each aspect was measured by three to four questions. The absolute fit measures of the overall model fit are: χ^2/df =3.372 (χ^2 =205.715, df=561, p<0.001), GFI = 0.918, AGFI = 0.877, SRMR = 0.052, RMSEA = 0.082. The relative fit measures include NFI = 0.924, IFI = 0.945, CFI = 0.945 and RFI = 0.902, while the parsimonious fit measures include PNFI = 0.722, PCFI = 0.739 and PGFI = 0.615. The comparison between sample data and the hypothetical model shows a satisfactory model fit. Figure 3 and Table 3 show that each path coefficient of the research hypotheses are significant and, therefore, are accepted. In other words, acceptance by teachers of an IWB-based teaching model shows a positive response in the interactions among PEU, PU, BI and AU. The relations between PEU and PU (0.88), as well as between BI and AU (0.70), have the strongest explanatory power.

In the overall model, perceptions can explain 56% and 49% of the variance in behavioural intention to use and actual system use respectively.

Table 3: SEM path analysis.

paths	*SRW*	*SE*	*t*-value
PEU→PU	0.88	0.78	17.437***
PU→BI	0.38	0.56	2.572**
PEU→BI	0.39	0.56	2.576**
BI→AU	0.70	0.49	8.329***

Note: *** p <.001, ** p <.01; SRW: standardised regression weights, SE: standard error

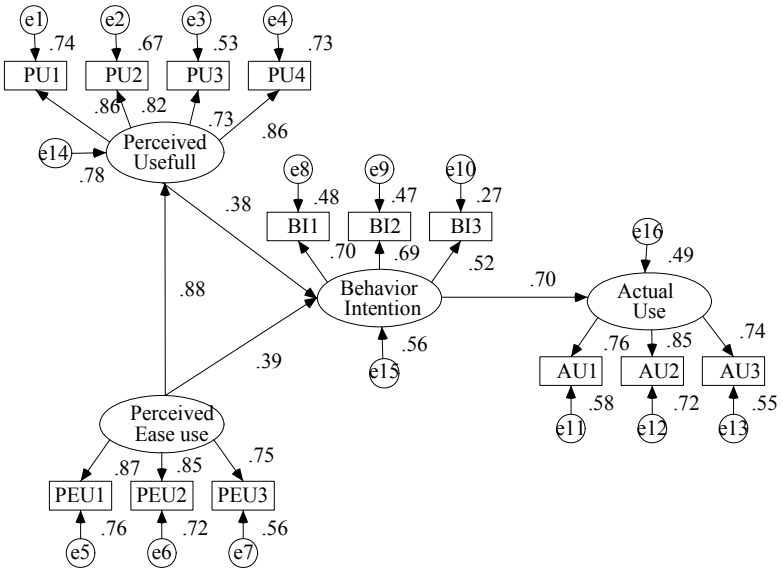

Figure 3: TAM structural model for rural teachers.

CONCLUSIONS

Teachers generally consider that ICT teaching models have matured; however, teachers have reservations over their actual applicability. In particular, the use of new teaching interface tools, such as IWB, still faces some challenges. This study examined teachers' acceptance of IWB use in schools in remote areas, in order to understand the impact of teacher perceptions, behavioural intention to use and actual system use. This study found that rural teachers show a high level of acceptance of both the observed variables and latent aspects of their perceptions. Adopting SEM, CFA was first used to confirm the model fit to the research hypotheses before further analyses.

The obtained results showed not only a satisfying model fit, but also the research hypotheses were accepted. Based on this, some conclusions can be drawn: 1) PEU has a positive impact on PU, showing that the user-friendly interface of IWB is favoured by teachers, and they do not encounter great difficulties or show resistance to learning and using it; 2) The positive and direct impact of both PEU and PU on BI were observed, which shows that higher the convenience and practicability of IWB use can enhance teachers' behavioural intention to use; and 3) BI has a direct impact on AU, showing that IWB-based teaching generally has been accepted by teachers in practice, and has been applied in actual teaching locations. Conclusions reached in this study correspond with many other ICT studies [46-48].

In other words, the preconditions for designing an ICT teaching system should be its perceived ease of use, and its practicability, so that teachers' behavioural intention to use will naturally increase, and their actual system use be improved. Therefore, this first principle should be considered during the promotion of policy by governments and educational administrators. Second, teachers' resistance can be reduced through practical on-the-job training or teaching demonstrations. Finally, promotion of ICT education is a long-term task. While concern about the digital divide among students is warranted, teachers' level of acceptance also should be considered in order to prevent an unnecessary waste of educational investment.

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