An Investigation on User Communication Behavior in an Interactive Whiteboard Technology Environment

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Abstract: - Interactivity is the key characteristic in interactive whiteboard technology (IWT). This study aims to provide a better understanding of communication behavior in IWT. This research's objective is to investigate the effects of the interactivity level on a user's attitude and intention toward the use of IWT. As a result, we cite the technology acceptance model (TAM) to support this research. Specifically speaking, our test consisted of system characteristics (interactivity) and extrinsic motivation (TAM), in an integrated theoretical framework of IWT behavior. A survey of 340 elementary school students found strong support for the model. We used the confirmatory factor analysis (CFA) to examine the measurement model, and applied structure equation modeling to access the empirical strength of the relationships in the proposed framework. Overall, the conclusions were placed into two categories: methodological and theoretical. On the methodological front, we demonstrate the development of a reliable and valid measure that captures a critical construct to understand IWT behaviors. On the theoretical front, the results reveal that attitude and behavioral intention are directly/indirectly affected by interactivity, perceived ease of use, and perceived usefulness.

Key-Words: - Interactive whiteboard technology (IWT), Interactivity, Technology Acceptance Model (TAM)

1 Introduction

E-learning has recently become a promising alternative to traditional classroom learning, helping society move toward a vision of lifelong and ondemand learning [23]. It has become one of the fastest-moving trends and aims to provide a configurable infrastructure that integrates learning material, tools, and services into a single solution to create and deliver training or educational content quickly, effectively, and economically [20].

In a small-scale study of Information and Communication Technology in primary schools, interactive whiteboard technology (IWT) was found to be the predominant information communication technology (ICT) tool used by teachers [16]. Many studies reported on the significance of IWT in classrooms [4], [6]. IWT can help teachers, students, trainers, and school district office personnel with their work. It can save every step of student's work, which can be played back and used for assessment. It cites that collaboration on complicated problems have become much easier to understand when it is done with a whiteboard [4]. Furthermore, it points out that some interactive whiteboard software can hide portions of the screens to be revealed at one's discretion [4].

The early interactivity studies, however, did not propose a complete theoretical framework and only concerned the perception of its users. Some studies primarily offered guidelines [31], but waited for others to specify their findings. Moreover, other studies solely focused on the characteristics or dimensions of interactivity [32], [33]. Teo et al. offered a structure model, but didn't concern the interactivity of uses' perceptions [38]. However, McMillan and Hwang validated the measures of perceived interactivity (MPI) offering researchers a tool for measuring a consumer perception [19].

As the results mentioned above, in this research, we adopted MPI to measure the user perceived interactivity, and proposed an integrated model combined with a technology acceptance model [5] to provide a better understanding of IWT.

In this paper, we use a quantitative modeling framework to develop a structure model that embodies the components of a compelling IWT experience. We use data collection from a sample which is an experienced elementary school student's survey. We use this sample to measure these constructs and fit a series of structural equation models that test related prior theories including interactivity, and technology acceptance model (TAM).

2 Theoretical foundation and hypotheses

2.1 E-learning

Extensive research has shown that students benefit from e-learning [21]. Some of the benefits are that it: provides time and place flexibility; results in cost and time savings for educational institutions; fosters self-directed and self-paced learning by enabling learner-centered activities; creates a collaborative learning environment by linking each learner with physically dispersed experts and peers; and allows knowledge to be maintained and updated in amore timely and efficient [8].

2.2 Interactive whiteboard technology (IWT)

Most IWT literatures are highly positive about the impact and the potential of the technology [14], [24], [30]. Therefore, some of the advantages associated with the use of IWT that it identifies are: (a) it facilitates the effective integration of multimedia in the traditional ICT classroom [14], it facilitates the design of activities/materials which are tailored to meet the needs of students with diverse learning styles [30], (b) its use to enhance motivation, interaction and collaborative learning in the classroom [25], and (c) it has a positive impact on students' and teachers' developments of ICT skills and attitudes towards the use of computers for teaching - learning [10]. However, these studies also mention some drawbacks of IWBs technology, such as (a) teachers' concern about making lessons more teacher-centered if too much focus is given to the IWBs technology [9] and (b) teachers' feeling of ineptitudes and lacks of competence concerning their knowledge of ICT [9].

2.3 Interactivity

Interactivity is a person-to-person or person-totechnology exchange designed to effect a change in knowledge or behavior of at least one person [35]. The degree to which a communication system can allow one or more end users to communicate alternatively as senders or receivers with one or many other users or communication devices, either in real time or on a store-and-forward basis, or to seek and gain access to information on an ondemand basis where the content, timing and sequence of the communication are under control of the end users, as opposed to a broadcast basis [36]. Hoffman and Novak identified two levels of interactivity: machine interactivity at the low end and person interactivity at the high end [37]. Machine interactivity refers to the extent to which users can participate in modifying the form and content of a mediated environment in real time. Person interactivity is defined as interactivity between people that occurs through a medium or is unmediated, such as in the case of face-to-face communication [38].

Therefore, machine interactivity is interactivity with the medium, while people interactivity is the interactivity through the medium. Szuprowicz [39] further divides machine interactivity into two different levels: user-document interactivity at which level users are not able to influence or manipulate file contents and user-system interactivity at which level users can manipulate the content by changing its characteristics. At the level of user-user interactivity defined by Szuprowicz [39], users operate real time to create response among two or more users.

Prior research has identified an additional dimension of perceived interactivity called "direction of communication". These studies have applied either the traditional organizational communication model [12] or the interpersonal communication model Direction [22]. of communication is the extent to which users believe that the site facilitates two-way communication. In summary, perceived interactivity includes three dimensions: (1) control (internally based efficacy), (2) responsiveness (externally based system efficacy), and (3) communication [18], [19].

2.4 Technology Acceptance Model (TAM)

Technology acceptance model (TAM) was conceived to explain and predict the individual's acceptance of IT. TAM is based on Fishbein and Ajzen's Theory of Reasoned Action (TRA), which suggests that social behavior is motivated by an individual's attitude toward carrying out that behavior, a function of one's beliefs about the outcome of performing that behavior, and an evaluation of the value of each of those outcomes.

According to TRA, behavior is determined directly by the intention to perform, because people, in general, behave as they intend to do within available context and time.TAM adopts TRA's causal links to explain individual's IT acceptance behaviors. It suggests that perceived usefulness and perceived ease of use of IT are major determinants of its usage. Davis defined perceived usefulness as "the degree of which a person believes that using a particular system would enhance his/her job performance" and perceived ease of use as "the degree of which a person believes that using a particular system would be free of effort" [5]. Consistent with TRA, user's beliefs determine the attitudes toward using the system. Behavioral intentions to use, in turn, are determined by these attitudes toward using the system.

Finally, behavioral intentions to use lead to actual system use. Previous research has demonstrated the validity of this model across a wide variety of corporate IT [5], [42], [43]. One obstacle to TAM usage is applying it beyond the workplace. This is because TAM's fundamental constructs do not fully reflect the variety of user task environments. Recently, Dishaw and Strong pointed out that a weakness of TAM is its lack of task focus [40]. Therefore, to increase external validity of TAM, it is necessary to further explore the nature and specific influences of technological and usage-context factors that may alter the user's acceptance.

2.5 Development of hypotheses

System characteristics have the potential to directly affect both perceived ease of use and perceived usefulness of information system (IS) [5]. Studies that included system features such as external variables of TAM have found significant relationships between the system variables and the TAM's beliefs constructs [41]. There is a need to identify specific system characteristics and examine its effects on both perceived ease of use and perceived usefulness in IWT environments. In this study, we define the interactivity as the most important in system characteristics. Perceived interactivity includes three dimensions: (1) control (internally based efficacy), (2) responsiveness (externally based system efficacy), and (3) communication [18], [19]. As the result, we will discuss the relationship of interactivity with other variables. We propose the hypothesis as follows:

We propose the hypothesis as follows: Hypothesis 1: Greater control interactivity corresponds to greater perceived ease of use. Hypothesis 2: Greater responsiveness interactivity corresponds to greater perceived ease of use. Hypothesis 3: Greater communication interactivity corresponds to greater perceived ease of use. In the literature reviewed, several authors have emphasized the potential of IWT for facilitating more interactive lessons [2], [9], [11]. An ideal class using IWT would feature students and teachers working together to construct the content of the lesson by using the resources available by the technology and relying on the expertise of the whole class [2], [9], [11]. They argue that teachers should adopt a more interactive approach to teaching if they want the IWT to become a transformative device to enhance learning. Bell also emphasized the potential of IWT for promoting higher levels of interactivity [2].

We propose the hypothesis as follows:

Hypothesis 4: Greater control interactivity corresponds to greater perceived usefulness. Hypothesis 5: Greater responsiveness interactivity corresponds to greater perceived usefulness. Hypothesis 6: Greater communication interactivity corresponds to greater perceived usefulness.

Perceived ease of use is one major determination of attitude toward use in the TAM model, and many empirical studies confirmed the effect of ease of use on attitude toward using [5], [42], [43]. This internal belief ties to an individual's assessment of the mental effort involved in using a system [5]. Perceived usefulness and perceived ease of use are distinct but related constructs. Improvements in perceived ease of use will contribute to improved performance. Since improved performances define perceived usefulness that is equivalent to usefulness, perceived ease of use will have a direct and positive effect on perceived usefulness.

Extensive research over the past decade provides evidence of the significant effect of perceived ease of use on intention, either directly or indirectly through its effect on perceived usefulness [42], [43], [44], [45].

Accordingly, the following hypotheses were proposed:

Hypothesis 7: Greater perceived ease of use corresponds to greater perceived usefulness.

Hypothesis 8: Greater perceived ease of use corresponds to greater attitude toward using.

Perceived usefulness in the TAM model originally referred to job related productivity, performance, and effectiveness [5]. This is also an important belief identified as providing diagnostic insight into how user attitude toward using and intention to use are influenced - perceived usefulness has a direct effect on intentions to use over and above its influence via attitude [5], [43], [44], [45], [46]. Accordingly, the following hypotheses were proposed:

Hypothesis 9: Greater perceived usefulness corresponds to greater attitude toward using. Hypothesis 10: Greater perceived usefulness corresponds to greater behavioral intention.

Attitude has long been identified as a cause of intention. Attitude toward using in the TAM model is defined as the mediating affective response between usefulness and ease of use and behavioral intention to use a target system. In other words, a prospective user's overall attitude toward using a given system is an antecedent to intention to adopt [5], [42], [43], [44], [45].

Accordingly, the following hypothesis was proposed:

Hypothesis 11: Greater attitude toward using corresponds to greater behavioral intention.

Fig. 1 illustrates our model, which is based on TAM and related literature.



Fig.1 Research model

3 Methodology

3.1 Sample

To test the hypotheses, an online field survey was conducted. It used a questionnaire designed to be placed on a web site. Javascript and asp.net programming was developed to handle the data collection process. Our research subjects were fifth and sixth grade elementary school students IWT users in Taiwan. The formal questionnaire survey was expected to generate 300 respondents at least, with around 100 respondents for each online communication tool. Telecommunication Laboratories and the questionnaire collection were kept running continuously for two weeks of the survey period. The online questionnaire's web address was first sent to students. The contents of this message requested them to fill out the questionnaire and also forwarded the web address in hopes of increasing the sample size of study. The online survey generates raw data automatically in a database. It saved a lot of time and avoided the possibility of human mistakes during data coding. Table 1 summarizes the respondents' profile.

Measure Items		Frequency	Percent
Gender	Male	182	53.5
	Female	158	46.5
Place of	General	215	63.2
IWT	class		
	ICT class	125	36.8
Experience	Under 3	70	20.6
in IWT	months		
	3 months–6	140	41.2
	months		
	6 months–1	95	27.9
	year		
	Over 1 years	35	10.3
Time in	Under 10 h	200	58.9
IWT per	11–20 h	105	30.8
week	Over 21 h	35	10.3

Table 1. Demographic profile

3.2 Measurement development

The questionnaires were developed from material discussed and tested previously; the list of items is displayed in Appendix A. The items were slightly modified to suit the context of IWT. Our scale items for perceived ease of use, perceived usefulness, attitude, and behavioral intention to IWT were from [5], [17], [29]. Interactivity was measured by items adapted from Liu, McMillan and Hwang [19]. Each item was measured on a seven-point Likert scale, ranging from "disagree strongly" (1) to "agree strongly" (7). Before conducting the main survey, we performed a pretest and a pilot to validate the instrument. The pre-test included thirty-five elementary school students who were experienced IWT participants. Respondents were asked to comment on list items that corresponded to the constructs, including scales wording, questionnaire format, and instrument length. Finally, to reduce any possible ambiguity, a pilot test was performed.

4 Results

4.1 Descriptive statistics

Descriptive statistics were calculated and shown in Table 2. These show that, on average, our sample responded positively to participating in IWT (the averages of all constructs were greater than 5 out of 6).

N=340	Means	S.D.
Control	5.43	1.00
Responsiveness	5.57	1.08
Communication	5.54	1.10
Usefulness	5.52	0.98
Ease of use	5.27	1.08
Attitude	5.53	1.11
Behavioral	5.46	1.14
intention		

Table 2. Descriptive statistics (means and S.D.)

4.2 Analytic strategy for assessing the model

The proposed model was evaluated using SEM analysis, which is a powerful second-generation multivariate technique for analyzing causal models with an estimation of the two components of a causal model, measurement and structural models. The measurement model is estimated using confirmatory factor analysis (CFA) to test whether the constructs possess sufficient reliability and validation. The structural model is used to investigate the strength and direction of the relationship between the theoretical constructs. Such analyzed technique has been widely applied in recent years. In our study, LISREL 8.7 was the software used to assess the confirmatory factor analysis (CFA) and the structural models [15].

4.3 The measurement model

The measurement model was tested using confirmatory factor analysis (CFA). Segars and Grover [27] suggested that the measurement model should be evaluated first and then changed as necessary to generate the 'best fit' model. The initial assessment of the model indicated that some items should be removed. So, after changing the instruments, 20 items were retained, as shown in Table 3. Item reliability ranged from 0.73 to 1.06, which exceeded the acceptable value of 0.50 recommended by Hair et al. [13]. The internal consistency of the measurement model was assessed by computing the composite reliability (CR). Consistent with the recommendations of Bagozzi and Yi [1], all composite reliabilities were above the 0.60 benchmark. The average variance extracted all constructs exceeded the threshold value of 0.5 recommended by Fornell and Larcker [7].

Additionally, the values of reliability were above the recommended thresholds, and the scales for evaluating the constructs were deemed to exhibit convergence reliability. Variances extracted by constructs were greater than any squared correlation among constructs; this implied that constructs were empirically distinct, and as shown in Table 4. In summary, the measurement model testing, including convergent and discriminate validity measures, was satisfactory. The fitness measures for the measurement models as shown in Table 5. $\chi 2$, GFI (goodness-of-fit index), AGFI (adjusted GFI), NFI (normalized fit index), CFI (an incremental fit index of improved NFI) and RMSEA (root-mean-square error of approximation) were used to test the goodness of fit of the proposed model. It is suggested that χ^2/d .f. should not exceed 3 [3] while GFI and AGFI should be greater than the recommended value of 0.8 [26], [28]. Bentler further suggested that model fit indices should be used, and scores of 0.9 or higher on NFI and CFI should be considered evidence of a good fit. Accordingly, all the fitness measures in this study fell into acceptable ranges. Consequently, the proposed model provided a suitable fit condition.

Table 3. Reliability (Notes: $^{R} =$	Reverse coding.)
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Item	Measure	Item	Composite	Average variance
		reliablity	reliablity	extracted
COM1	This IWT facilitates two-way communication.	1.04	0.84	0.62
COM2	The IWT gives me the opportunity to talk back.	1.06		
COM5	The IWT does not encourage visitors to talk back. ^R	0.91		
CON2	While I was on the IWT, I always knew where I	0.94	0.75	0.65
	was going.			
CON3	While I was on the IWT, I was always able to go	0.91		
	where I though I was going.			
CON4	I was delighted to be able to choose which link and	0.73		
	when to click.			
RES1	The IWT processed my input very quickly.	1.03	0.88	0.51
RES3	I was able to obtain the information I want without	0.95		
	any delay.			
RES5	The IWT was very slow in responding to my	1.05		
	request. ^R			
PU2	Using IWT enables me to accomplish purpose	0.90	0.75	0.53
	more quickly			
PU3	It enables me to satisfy the purpose of using IWT	0.88		
	easier			
PU4	Overall, it will be useful using IWT	0.76		
PE1	Learning to operate IWT is easy for me	1.01	0.77	0.64
PE3	It is easy to remember how to use IWT	0.98		
PE4	Overall, it will be easy to use IWT	0.85		
AT1	I'll like to use IWT	1.02	0.85	0.50
AT2	Using IWT will bring profit for me	1.04		
AT4	Using IWT is a pleasant idea	1.02		
BI2	I will strongly recommend others to use IWT	1.02	0.77	0.72
BI4	It is worth to using IWT	0.97		

	COM	CON	RES	PU	PE	AT	BI
COM	0.80						
CON	0.12	0.71					
RES	0.14	0.26	0.85				
PU	0.13	0.36	0.17	0.71			
PE	0.17	0.24	0.08	0.68	0.73		
AT	0.15	0.08	0.01	0.41	0.30	0.81	
BI	0.06	0.11	0.01	0.34	0.29	0.75	0.79

Table 4. Discriminant validity of users

Table 5. Overall fits of models

Fit index	Recommended criteria	Results	Suggested by authors
χ2/d.f.	<3	1.03	Bentler and Bonett [3]
GFI	>0.8	0.96	Seyal et al. [28]
AGIF	>0.8	0.94	Scott [26]
NFI	>0.9	0.96	Bentler and Bonett [3]
NNFI	>0.9	0.99	Bentler and Bonett [3]
RMSEA	<0.08	0.01	Hair et al. [13]
CFI	>0.9	0.99	Bentler and Bonett [3]

4.4 Tests of the structural model

We examined the structural equation model by testing the hypothesized relationships among the research variables; see Fig. 2. The results show that attitude and perceived usefulness identification had significant effects on the intention to use (β = 0.70, p < 0.001; β = 0.16, p < 0.05), supporting hypotheses 10 and 11. Together, these two paths accounted for 60% of the variance in intent to use.



Fig.2 Hypotheses Testing Results: Structural Equation Model

Perceived usefulness identification had significant effects on attitude toward using (β = 0.12, p < 0.05), supporting hypotheses 9. It accounted for 12% of the variance in attitude toward using. Contrary to expectations, perceived ease of use had no direct influence on attitude toward using (0.09, p > 0.05), thus hypothesis 8 was not supported.

Also the results showed that perceived ease of use (β = 0.70, p < 0.001), control interactivity (β = 0.17, p < 0.05), communication interactivity (β = 0.11, p < 0.05) and responsiveness interactivity (β = 0.12, p < 0.05) significantly affected perceived usefulness, providing support for hypotheses 4, 5, 6, and 7. Together, these four paths accounted for 59% of the variance in perceived usefulness.

Table 6. Summary of Hypothesis Test

List	Hypothesis	Test result
H1	Greater control interactivity corresponds to greater	Supported
	perceived ease of use.	
	Greater responsiveness	
H2	interactivity corresponds to	Supported
	greater perceived ease of use.	
112	Greater communication	G (1
H3	interactivity corresponds to	Supported
	greater perceived ease of use.	
114	Greater control interactivity	Summented
П4	paragived usefulness	Supported
	Greater responsiveness	
H5	interactivity corresponds to	Supported
115	greater perceived usefulness	Supported
	Greater communication	
H6	interactivity corresponds to	Supported
	greater perceived usefulness.	I I I I I I I I I I I I I I I I I I I
	Greater perceived ease of use	
H7	corresponds to greater	Supported
	perceived usefulness.	
	Greater perceived ease of use	Not
H8	corresponds to greater	Supported
	attitude toward using.	Supported
	Greater perceived usefulness	
H9	corresponds to greater	Supported
	attitude toward using.	
1110	Greater perceived usefulness	a
HIO	corresponds to greater	Supported
	Denavioral intention.	
U 11	Greater attitude toward using	Supported
пп	behavioral intention	Supported

Finally, control interactivity (β =0.22, p<0.05), responsiveness interactivity (β = 0.14, p < 0.05) and communication interactivity (β =0.14, p<0.05) significantly affected perceived ease of use, providing support for hypotheses 1, 2 and 3. Together, these three paths accounted for 10% of the variance in perceived ease of use. The results of testing hypotheses are summarized in Table 6.

5 Conclusions and recommendations

An individual's attitude and behavioral intention toward the use of the IWT tools are directly or indirectly affected by the individual's perceptions about the interactivity, ease of use, and usefulness. At the same time, behavioral intention to use the IWT tools is highly related to the attitude and perceived usefulness. These results imply that the individual's acceptance of the IWT tools is significantly related to motivation factors.

5.1 Conclusions

The purpose of this study is to propose an integrated theoretical model, including interactivity, and the factors of TAM, to examine the IWT behavior, especially the acceptance of IWT tools. We verified the effect of interactivity, perceived ease of use, and perceived usefulness on the behavior of IWT tools. The conclusions drawn from the present exercise can be placed into two categories: methodological and theoretical.

On the methodological front, we have demonstrated the development of a reliable and valid measure to capture a critical construct to understand IWT behaviors [34]. On the theoretical front, our study makes several contributions to the literature. First, we investigate how constructs (including perceived ease of use, and perceived usefulness) are influenced by the interactivity. We found that increased levels of interactivity will lead to increased levels of perceived ease of use, and perceived usefulness. Similar findings have been reported in other studies [38], [47]. The most telling finding would appear to be, that we have identified two relevant constructs that may influence intent to use IWT tools. Judged by the direct and indirect (i.e., via attitude) effect on behavioral intention, perceived usefulness was proposed as one of the determinant of acceptance.

Rationally, users would want to use IWT tools only if they found them useful. Perceived ease of use is another important predictor of intention to use IWT tools. But if difficulties of use cannot be overcome, then the user may not perceive the usefulness and may not enjoy the IWT. Therefore, the user friendly interface of an IWT tool also played a critical role in determining perceptions of usefulness and attitude toward using. However, according to the analytical results, perceived ease of use did not appear to drive attitude toward using.

This study assumes that ease of use in IWT tools doesn't matter when the user attitude is concerned. Hence, attitude toward using is not driven by ease of use. However, our study still indicates that interactivity, perceived ease of use, and perceived usefulness are salient beliefs about IWT, which support our hypotheses and such results reinforce previous findings [5], [42], [43], [44], [45].

5.2 Implications: Theoretical and Practical 5.2.1 Theoretical Implications

From the standpoint of individual-level technology acceptance research, this study extends TAM with the interactivity theory. Although TAM-related hypotheses are supported here, the results challenge some of the basic tenets of TAM. TAM emphasized the importance of perceived usefulness as the key determinant of user acceptance of IT, and our study had the same result. Besides, interactivity factors had a significant effect on perceived ease of use and perceived usefulness. This means that motivational factors have a powerful effect in building positive attitudes.

As a result, for academic researchers, this study contributes to a theoretical understanding of factors that promote not only task-oriented IT but also entertainment-oriented IT. Entertainment-oriented IT differs from task-oriented IT in terms of the reason to use it. Task-oriented IT usage is concerned with improving organization productivity. Therefore, TAM emphasizes the importance of perceived usefulness and perceived ease of use as key determinants. However, concerning entertainmentoriented IT, this study demonstrated the importance of an individual intentions to need the other variable, such as an interactivity experience. Furthermore, this dominance was strong, and explained most of the variance in technology usage.

5.2.2 Practical Implications

This study has provided support to the research in confirming the positive effects of interactivity including user-machine interactivity and user-user interactivity. When user-user interactivity is incorporated into an IWT environment, designers need to be aware of the highly dynamic interaction between social and technological factors and how they influence technology acceptance. Although ease of use and usefulness are conceived as important issues in traditional IT environments; interactivity experience plays an important role in increasing usability in the IWT environment, which contains entertainment-oriented applications. Therefore, for IWT tool practitioners, the results suggest that developers should endeavor to emphasize interactivity on IWT using [45]. The level should be optimized for the constraints of users' neural bandwidth and skills. If too much interactivity is provided than the users can take, it is unlikely to keep their attentions very long. Furthermore, the bandwidth of the infrastructure delivering the interactivity must be taken into consideration to ensure that the access speed is not hampered by the increased interactivity. In conclusion, designers should keep users in a flow state.

The results also have significant implications for advertisers. Because IWT environments could be taken as a new media, it has the capacity of making and impact on attitude formation and change, and therefore can be interesting and potentially powerful outlets for learner communication. However, in conventional vehicles, the "more-is-better" approach not necessarily lead does to enhanced communication effectiveness. As complexity the of the advertisement increases, the challenge increases, and users feel it is hard to use, therefore, the possibility of returns on its effectiveness diminishes. However, if the interactive features and design elements are properly balanced, the new media has the ability to impact favorably on involvement, which has been traditionally hard to achieve in conventional media.

5.3 Research Limitations

Although our findings provide meaningful implications for IWT environment, our study does have some limitations. First, the use of self-reporting scales to measure study variables suggests the possibility of a common method bias for some of the results. In order to pursue further investigation, it would be appropriate to develop a more direct and objective measure for user acceptance of the IWT tools.

Second, although the structured equation modeling technique used was able to handle small samples, more statistical conclusion validity could be achieved with a larger population. Furthermore, this study was conducted with one-shot experimental design, so a longitudinal approach should also be considered.

Third, we used students in a Taiwan elementary school, who were appropriate for this research.

Results should be able to be generalized across different populations. However, currently, we cannot offer empirical support that they do.

Finally, we investigate how beliefs, including perceived ease of use, and perceived usefulness are influenced by interactivity; but there are still a lot of other externally controllable factors that we didn't discuss, such as individual and task characteristics, and cultural factors which would allow us to better understand the usage of communication technology.

Appendix A. List of items by construct Communication

- 1. This IWT facilitates two-way communication.*
- 2. The IWT gives me the opportunity to talk back.*
- 3. The IWT facilitates concurrent communication.
- 4. The IWT enables conversation.
- 5. The IWT does not encourage visitors to talk back. $_{R^{\ast}}$

Control

1. While I was on the IWT, I was always aware where I was.

2. While I was on the IWT, I always knew where I was going.*

3. While I was on the IWT, I was always able to go where I though I was going.*

4. I was delighted to be able to choose which link and when to click.*

5. I feel that I have a great deal of control over my visiting experience at this IWT.

Responsiveness

- 1. The IWT processed my input very quickly.*
- 2. Getting information from the IWT is very fast.

3. I was able to obtain the information I want without any delay.*

4. When I clicked on the links, I felt I was getting instantaneous information.

5. The IWT was very slow in responding to my request. R^*

Perceived ease of use

- 1. Learning to operate IWT is easy for me.*
- 2. I find it easy to get IWT to do what I want to do.
- 3. It is easy to remember how to use IWT.*
- 4. Overall, it will be easy to use IWT.*

Perceived usefulness

1. Using IWT improves my purpose quality.

2. Using IWT enables me to accomplish purpose more quickly.*

3. It enables me to satisfy the purpose of using IWT easier.*

4. Overall, it will be useful using IWT.*

Attitude toward using

- 1. I'll like to use IWT.*
- 2. Using IWT will bring profit for me.*
- 3. I'll be positive about using IWT.
- 4. Using IWT is a pleasant idea.*

Behavioral intentions to use

- 1. I will frequently use IWT in the future.
- 2. I will strongly recommend others to use IWT.*
- 3. I'll intend to use IWT as soon as possible.
- 4. It is worth to using IWT.*

Notes: R = Reverse coding.

*: Denotes the retained items for data analysis.

References:

- [1] R. P. Bagozzi and Y. Yi, On the evaluation of structural equation models, *Journal of the Academy of Marketing Science*, Vol. 16, 1998, pp. 74-94.
- [2] M. A. Bell, Impact of the electronic interactive whiteboard on students attitudes and achievement in eighth-grade writing instruction, Baylor University, 2000.
- [3] P.M. Bentler and D.G. Bonett, *Significance tests* and goodness of fit in the analysis of covariance structures, Psychological Bulletin, 1989.
- [4] J. Branzburg, Whiteboards at Your Service, *Technology & Learning*, Vol. 28, 2007, pp. 38-39.
- [5] F.D. Davis, Perceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly*, Vol. 13, No. 3, 1989, pp. 319-340.
- [6] S. W. Draper and M. I. Brown, Increasing interactivity in lectures using an electronic voting system, *Journal of Computer Assisted Learning*, Vol. 20, 2004, pp. 81-94.
- [7] C. R. Fornell and D.F. Larcker, Structural equation models with unobservablevariables and measurement error, *Journal of Marketing Research*, Vol. 18, 1981, pp. 39-50.
- [8] K. Pituch and Y. Lee, The influence of system characteristics on e-learning use, *Computers & Education*, Vol. 47, 2006, pp.222-244.
- [9] D. Glover and D. Miller, Running with technology: the pedagogic impact of the largescale introduction of interactive whiteboards in one secondary school, *Journal of Information Technologies for Teacher Education*, Vol. 10, No. 3, 2001, pp. 257-278.
- [10] T. Goodison, Enhancing learning with ICT at primary level, *British Journal of Educational Technology*, Vol. 33, 2002, pp. 215-228.

- [11] C. Greiffenhagen, From traditional blackboards to interactive whiteboards: a pilot study to inform technology design, *In Proceedings of the* 24th international conference psychology of mathematics education, Vol. 24, No. 2, 2000, pp 305-312.
- [12] J. E. Grunig, and L. A. Grunig, Toward a Theory of Public Relations Behavior of Organizations: Review of a Program of Research, New Jersey: Lawrence Erlbaum Associates, 1989.
- [13] J.F. Hair, R.E. Anderson, R.L. Tatham, and W.C. Black, *Multivariate Data Analysis with Readings*, New York: MacMillan, 1992.
- [14] I. Hall and S. Higgins, Primary school students' perceptions of interactive whiteboard, *Journal of Computer Assisted Learning*, Vol. 2, 2005, pp. 102-117.
- [15] K.G. Joreskog and D. Sorbom, *LISREL 8: Users'Reference Guide*, Chicago: Scientific Software International, 1996.
- [16] S. Kennewell and G. Beauchamp, The features of interactive whiteboards and their influence on learning, *Learning, Media, & Technology*, Vol. 32, 2007, pp. 227-241.
- [17] V.S. Lai and H. Li, Technology acceptance model for internet banking: an invariance analysis, *Information & Management*, Vol. 42, 2005, pp. 373-386.
- [18] Y. Liu, Developing a Scale to Measure the Interactivity of Websites, *Journal of Advertising Research*, Vol. 43, No. 3, 2003, pp. 207-216.
- [19] S. J. McMillan and J.-S. Hwang, Measures of Perceived Interactivity: An Exploration of the Role of Direction of Communication, User Control, and Time in Shaping Perceptions of Interactivity, *Journal of Advertising*, Vol. 31, No. 3, 2002, pp. 29–41.
- [20] C.-S. Ong, J.-Y. Lai, and Y.-S. Wang, Factors affecting engineers' acceptance of asynchronous e-learning systems in high-tech companies, *Information & Management*, Vol. 41, 2004, pp. 795-804.
- [21] G. Piccoli, R. Ahmad, and B. Ives, Web-based virtual learning environments: a research framework and a preliminary assessment of effectiveness in basic IT skills training, *MIS Quarterly*, Vol. 25, 2001, pp. 401-426.
- [22] S. Rafaeli, *Interactivity: From New Media to Communication*, California: Sage Publications, 1988.
- [23] J. C. Rivera and M. K. McAlister, A comparison of student outcomes and satisfaction between traditional and Web based course offerings, *Proceedings of the 2001 Information Resources*

Management Association International Conference, 2001, pp. 770-772.

- [24] E. C. Schmid, Investigating the use of interactive whiteboard technology in the language classroom through the lens of a critical theory of technology, *Computer Assisted Language Learning*, Vol. 19, 2006, pp. 47-62.
- [25] E. C. Schmid, Using a voting system in conjunction with interactive whiteboard technology to enhance learning in the English language classroom, *Computers & Education*, Vol. 50, 2008, pp. 338-356.
- [26] J.E. Scott, The measurement of information systems effectiveness: Evaluating a measuring instrument, *Proceedings of the Fifteenth International Conference on Information System. Vancouver*, 1994, pp. 111-128.
- [27] A.H. Segars and V. Grover, Re-examining perceived ease of use and usefulness: a confirmatory factor analysis, *MIS Quarterly*, Vol. 17, 1993, pp. 517-252.
- [28] A.H. Seyal, M.N. Rahman, and M.M. Rahim, Determinants of academic use of the Internet: a structural equation model, *Behaviour and Information Technology*, Vol. 21, No. 1, 2002, pp. 71-86.
- [29] H.P. Shih, Extended technology acceptance model of Internet utilization behavior, *Information & Management*, Vol. 41, No. 6, 2004, pp. 719-729.
- [30] K. Wall, S. Higgins, and H. Smith, The visual helps me understand the complicated things': pupils views of teaching and learning with interactive whiteboards, *British Journal of Educational Technology*, Vol. 36, 2005, pp. 851-867.
- [31] D.W. Stewart and P.A. Pavlou, From Consumer Response to Active Consumer: Measuring the Effectiveness of Interactive Media, *Academy of Marketing Science Journal*, Vol. 30, No. 4, 2002, pp. 376-396.
- [32] R. Sims, Interactivity : A Forgotten Art ?, Computer in Human Behavior, Vol. 13, No. 2, pp. 157-180.
- [33] K. Chen and D.C. Yen, Improving the Quality of Online Presence through Interactivity, *Information & Management*, Vol. 42, 2004, pp. 217-226.
- [34] R.P. Bagozzi, Y. Yi, and L.W. Philips, Assessing construct validity in organizational research, *Administrative Science Quarterly*, Vol. 36, 1991, pp. 421-458.
- [35] S.H. Haeckel, About the Nature and Future of Interactive Marketing, *Journal of Interactive Marketing*, Vol. 12, No. 1, 1998, pp. 63-71.

- [36] D.R. Fortin and R.R. Dholakia, Interactivity and Vividness Effects on Social Presence and Involvement with a Web-Based Advertisement, *Journal of Business Research*, Vol. 58, 2005, pp. 387-396.
- [37] D.L. Hoffman and P.N. Thomas, Marketing in Hypermedia Computer-Mediated Environments: Conceptual Foundations, *Journal of Marketing*, Vol. 60, No. 3, 1996, pp. 50-68.
- [38] H.H. Teo, L.B. Oh, C. Liu and K.K. Wei, An Empirical Study of the Effects of Interactivity on Web User Attitude, *International Journal of Human-Computer Studies*, Vol. 58, 2003, pp. 281-305.
- [39] B.O. Szuprowicz, *Interactive Communications: New Technologies and Future Directions*, Computer Technology Research Corp, 1996.
- [40] M.T. Dishaw and D.M. Strong, Extending the technology acceptance model with tasktechnology fit constructs, *Information and Management*, Vol. 36, No. 1, 1999, pp. 9-21.
- [41] W. Hong, J.Y.L. Thong, W.M. Wong and K.Y. Tam, Determinants of User Acceptance of Digital Libraries: An Empirical Examination of Individual Differences and System Characteristics, *Journal of Management Information Systems*, Vol. 18, No. 3, 2002,pp. 97-124.
- [42] J.W. Moon and Y.G. Kim, Extending the TAM for a World-Wide-Web context, *Information and Management*, Vol. 38, 2001, pp. 217-230.
- [43] C.L. Hsu and H.P. Lu, Why do people play online games? An extended TAM with social influences and flow experience, *Information & Management*, Vol. 41, 2004, pp. 853-868.
- [44] I.L. Wu and J.L. Chen, An extension of Trust and TAM model with TPB in the initial adoption of on-line tax: An empirical study, *Human-Computer Studies*, Vol. 62, 2005, pp. 784-808.
- [45] J. Yu, I. Ha, M. Choi and J. Rho, Extending the TAM for a t-commerce, *Information and Management*, Vol. 42, 2005, pp. 965-976.
- [46] J. Lu, C.S. Yu, C. Liu and J.E. Yao, Technology Acceptance Model for Wireless Internet, *Internet Research*, Vol. 13, No. 3, 2003, pp. 206-222.
- [47] T.P. Novak, D.L. Hoffman and Y.-F. Yung, Measuring the Customer Experience in Online Environments: A Structural Modeling Approach, *Marketing Science*, Vol. 19, No. 1, pp. 22-42.