Interactive Technology and Smart Education

Learning with interactive whiteboards: Determining the factors on promoting interactive whiteboards to students by Technology Acceptance Model

Eylem Kilic Çetin Güler H. Eray Çelik Cemal Tatli

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Eylem Kilic, Çetin Güler and H. Eray Çelik
Yüzüncü Yil University, Van, Turkey, and
Cemal Tatli
Mus Alparslan University, Mus, Turkey

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Abstract

Purpose – The purpose of this study is to investigate the factors which might affect the intention to use interactive whiteboards (IWBs) by university students, using Technology Acceptance Model by the structural equation modeling approach. The following hypothesis guided the current study: *H1*. There is a positive relationship between IWB self-efficacy and perceived learning (PL). *H2*. There is a positive relationship between IWB self-efficacy and perceived ease of use (PEOU). *H3*. There is a positive relationship between IWB self-efficacy and perceived usefulness (PU). *H4*. There is a positive relationship between PL and PEOU. *H5*. There is a positive relationship between PL and PU. H6. There is a positive relationship between PEOU and attitude. *H7*. There is a positive relationship between PU and attitude.

Design/methodology/approach – A survey method was used to collect the data. Purposive sampling was used, and 416 high-school students participated in the current study. Descriptive statistics and structural equation model conducted to test the proposed model were used in data analysis.

Findings – All hypotheses formulated within the scope of the research model were statistically confirmed. *H1*, which assumed that interactive whiteboard self-efficacy (IWBSE) have had a positive impact on PL, was found to be statistically significant. The impact of IWBSE on PL was 0.61 which means that if IWBSE increases one unit, the impact on PL will be an average of 0.61 points. The relationship between IWBSE, which is expressed in *H2* and *H3*, and, respectively, PEOU and PU latent variables, was statistically significant. IWBSE mostly affected PEOU (= 0.51, $t = 7.92$), and then PU (= 0.16, $t = 2.43$). The relationship between PL – which is expressed in *H4* and *H5*– and, respectively, PEOU and PU latent variables, was statistically significant. IWBSE mostly affected PU (= 0.63, $t = 7.94$), and then PEOU (= 0.27, $t = 3.95$).

Originality/value – It is aimed to transform the entire classes into computerized classes (Smart Class) around Turkey with FATIH project which includes usage of interactive boards. Because it is a very big project funded by the government, it is important to evaluate its adaptation among teachers and students. Therefore, the current study aims to investigate the factors which might affect the attitude to use IWBs by high-school students.

Keywords Students, E-Learning

Paper type Research paper

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Introduction

There have been revolutionary changes and progresses in functionality and transmission of knowledge in educational field. Aksoy (2003) stated that the main purpose of education is to train individuals effectively and can contribute their intellectual progress. Because formal and effective education takes place in educational environments, using instructional technologies in education can contribute the effectiveness. In such an educational environment, training visionary individuals who can construct their own knowledge and transfer it into the real-world situations requires technology involvement. One of the actual and popular instructional technologies is Interactive Whiteboard (IWB). IWB can be defined as a touch-sensitive combination of a computer and a projector (Shenton and Pagett, 2008). Everything that can be done with a chalk on a blackboard and with a mouse on a computer can be done by using touch screen of an IWB (Ashfield and Wood, 2008). IWB can be considered as the interactive version of using computers and projection devices in classes (Türel, 2011).

IWB can positively impact learning processes and give opportunity for students to be more active during the processes. Therefore, students' perception toward IWB has become an important issue in utilizing IWB features. A widely used model to assess intention to use of technological devices is Technology Acceptance Model (TAM). TAM tries to explain intentions of users for a technological device by examining beliefs and attitudes of the users. In other words, it is assumed that, directly or indirectly, actual usage of a technology is influenced by perceived use of technology, perceived usefulness (PU) of the technology, one's behavioral intention and attitude. In addition, external factors can affect actual use of technology with mediated effects on PU and perceived ease of use (PEOU) (Park, 2009). The factors that affect high-school students' attitudes towards IWB usage were investigated in this study. TAM was considered as a suitable way to carry out this investigation.

Learning with interactive whiteboard

IWBs have been used in education since 1990s (Beeland, 2002). Teachers can benefit from IWBs to perform more effective teaching processes by developing/using rich, multimedia and interactive contents (Gillen *et al.*, 2007). IWBs can increase interaction, involvement and enrich learning environment in classrooms (Cogill, 2001). Also by using IWBs, teachers can make more eye contacts with students which can facilitate class management (Beauchamp, 2004). Türel and Demirli (2010) denoted some advantages of IWBs and emphasized that IWBs can contribute social interaction in classrooms and make learning processes more effective. Marking important parts on the screen, adding teachers' and/or students' comments/notes are the two advantages that Türel and Demirli (2010) denoted.

There are some studies (Pamuk *et al.*, 2013; Elaziz, 2008; Ashfield and Wood, 2008) which showed that teachers and students had positive attitudes toward IWBs. Beeland (2002) stated that IWBs increased students' attention and involvement and help teachers. Gillien *et al.* (2006) carried out a study that examines roles of IWBs in classrooms (facilitating student–student and student–teacher interaction, facilitating involvement in instructional process) and found out that IWBs increased involvement in instructional process, made the process more enjoyable and facilitated the presentation of the content more easily. Using IWBs in classrooms also support visual learning, making practices and improving computer skills (Paragină *et al.*, 2010). On the other

hand, not using or avoiding to use IWBs in classrooms is mostly caused by lack of technical or/and pedagogical knowledge of teachers or/and students (Türel, 2012).

Traditional blackboard usage in classrooms makes instructional process more teacher-centered; on the other hand, IWB usage by students in the process, help students to master their learning and have more productive, interactive, students-centered experiences (Geer and Barnes, 2007). Glover *et al.* (2003) carried out a study that showed that the students did not have enough confidence to use IWBs. Students should be given enough opportunities to use IWBs and teachers should improve their IWB usage skills (Shenton and Pagett, 2008).

Technology Acceptance Model

TAM was developed by Davis (1989) and it tries to explain users' behaviors toward technology use/acceptance. The model which was constructed on Theory of Reasoned Action is one of the most used models in the field of information systems. One of the reasons that the model is used so much lies beneath the clear and understandable structure of the model (Legris *et al.*, 2003; King and He, 2006). The model tries to explain effect of users' beliefs and attitudes toward technology use/acceptance on users' intentions. The model is used in educational field to investigate some situations such as acceptance of online courses by students, effective learning technologies, e-learning and teacher trainees' attitudes toward computers and their intentions to use computers relation (Legris *et al.*, 2003; King and He, 2006). The main components of the model are "perceived usefulness" and "perceived ease of use". PU is about the belief that using the new technology can increase performance and productivity in a task/work. PEOU is about the belief that using the new technology does not require too much time or effort. It is assumed that these main components can explain users' attitudes, intentions and real behaviors toward a new technology. In the TAM model, applied studies, numbers and types of variables have been changed as the amount of this kind of studies increased. It is indicated that TAM-related studies conducted between years 1999-2010 examined a lot of different variables but the main components of the model remained the same (Avcı-Yucel and Gulbahar, 2013).

IWB self-efficacy and TAM

Self-efficacy is an important factor that can affect the use of new technologies such as IWB and its intention to use (Hillier *et al.*, 2013). "Self-efficacy" is defined as a person's belief in their ability to complete a particular task (Bandura, 1986). As it is denoted, some new variables are added to the main variables of TAM (PU and PEOU) to benefit from TAM from different perspectives. One of these variables is computer self-efficacy. Venkatesh (2000) added and evaluated the impact of computer self-efficacy (CSE) – which relates to "one's confidence in mastering new technology" – (2011) within TAM. Venkatesh (2000) argued that ease of use can be affected by a person's pre-existing beliefs and perceptions of computers in general. Hillier *et al.* (2013) stated that "there is no study examining the potential impact of self-efficacy on the adaptation of the IWB". They tried to find out the effects on IWB self-efficacy on teachers and they reported high levels of general information and communication technologies (ICT) self-efficacy but low levels of self-efficacy with particular features and tools of the IWB. On the other hand, Shen and Chuang (2010) tried to find out the effects of IWB self-efficacy in the adaptation of IWB for students. They also found out that perceived self-efficacy has

positive impact on attitude. Stoel and Lee (2003) investigated the effects of students' experiences with Web-based learning technology on the acceptance of Web-based courseware. It is found that those experiences with the technology affect PEOU positively. In an earlier study (Igbaria *et al.*, 1995), it was found that the users' PEOU, usefulness and usage have been affected with the users' computer experiences. Although Hillier *et al.* (2013) evaluated IWB self-efficacy in reference to TAM, the present study was different from theirs in two ways. First, participants of this study were students not teachers. Second, IWB self-efficacy is tested in the model as a new variable. Compared to Shen and Chuang's (2010) study which assumed relationship between self-efficacy and attitude, this study assumes that perceived self-efficacy was related with PU, PEOU and perceived learning (PL). Therefore, it is assumed that IWB-self efficacy has an impact both on PEOU and PU. Additionally, it is assumed that IWB self-efficacy has a positive impact on PL of learners; it can be expected that the higher self-efficacy can help learners benefit from IWB's features and contribute their PL.

Perceived learning, IWB and TAM

Caspi and Blau (2008) defined PL as "the set of beliefs and feelings one has regarding the learning that has occurred. As such, PL is a retrospective evaluation of the learning experience". As pointed out by Caspi and Blau (2008), cognitive (Lapointe and Gunawardena, 2004) and social-emotional are two sources that can explain PL. Although these two sources are used to evaluate PL, the weight given to any source may not be known (Caspi and Blau, 2008). It is known that learning can occur when the learners perform activities that trigger specific learning mechanism rather than adding technology to course design (Dillenbourg, 1999). IWB has many features that can make classroom environment more interactive than before and allow students to be active during knowledge construction. Therefore, it can be assumed that if the interactive features of whiteboard are used to increase knowledge creation, it might lead to increase higher level of PL. However, students may be lacking confidence of using IWB (Glover *et al.*, 2003) and teachers may not give them enough opportunities to interact with IWBs (Shenton and Pagett, 2008). In this study, PL of the students was assumed to be effected by perceived self-efficacy of the students. PL of the students which is affected by self-efficacy was considered to have a positive influence on PU and PEOU.

Research model and hypothesis

The purpose of this study is to investigate the factors which might affect the intention to use IWBs by high-school students, using TAM by structural equation modeling (SEM) approach (Figure 1). The following hypothesis guided the current study (Table I).

Method

Participants

In total, 418 high-school students who were registered during the fall semester of 2012-2013 were the participants of this study. The participants were from the 9th grade (n = 55), 10th grade (n = 115), 11th grade (n = 178) and 12th grade (n = 70). Some descriptive statistics of the participants is given in Table II. More than half of the participants were males (n = 269). Almost half of them had intermediate level of computer experiences (n = 204) while some of them had expert level (n = 120). Most of

them learned to use IWB by themselves ($n = 205$) and from their teachers ($n = 135$). The IWB was mostly used for only some classes ($n = 236$) and only for 1-5 hours in a week.

Context and procedure

"Movement of Enhancing Opportunities and Improving Technology", known as FATIH project, is among the most significant educational investments in Turkey. FATIH Project proposes that "Smart Class" project is put into practice in all schools around Turkey. With this project, 42,000 schools and 570,000 classes will be equipped with the latest information technologies and will be transformed into computerized classes (Smart Class). Turkey has initiated FATİH Project to provide equal opportunities in education and improving technology use in schools. The main educational technologies that are supposed to provide these opportunities are tablet pc and interactive whiteboards. Each student from primary, secondary and high schools is equipped with tablet PCs and all the classes are to get equipped with interactive whiteboards and other required technologies. The hardware specification of the IWBs that were installed in the classrooms was Intel® Core™ İ3 as processor; Intel® HM65 board; Intel® HD graphics 3,000; 4GB DDR3 RAM; Sata HDD (in various capacities); 65" full HD multi-touch supported screen; audio, network; and input–output ports (usb, hdmi, vga). The IWBs run MS Windows 7 or Linux Pardus 2011 (customer choice) as operating system. Users could use the IWBs directly with the operating system which already installed or they can plug any other device like notebooks or tablet pc and control and use the IWBs with the content of these devices (FATİH, 2014).

Teachers are to be trained to use these technologies effectively and efficiently. In this transformation process, educational e-contents are going to be formed in accordance with the current teaching programs (FATİH, 2014). The participants of the present study were the students from a pilot school of FATİH project; which means they were

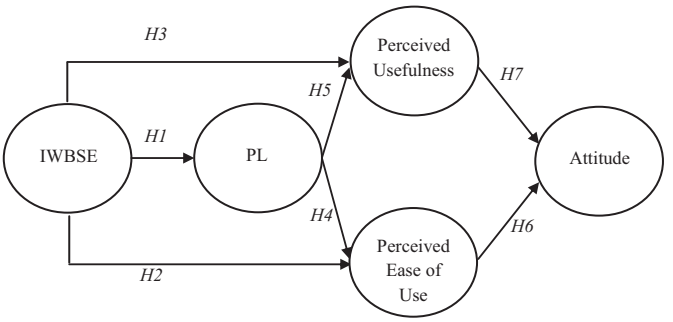

Figure 1.
The research model and the hypothesis

H1	There is a positive relationship between	IWB self-efficacy	Perceived learning	
H2			Perceived ease of use	
H3			Perceived usefulness	
H4		Perceived learning	Perceived ease of use	
H5			Perceived usefulness	
H6		Perceived ease of use	Attitude	
H7		Perceived usefulness		

Table I.
The hypothesis generated from five constructs

Variable	Frequency	(%)
Gender		
Female	147	35.3
Male	269	64.7
Grade		
9	53	12.7
10	115	27.6
11	178	42.8
12	70	16.8
Computer experiences		
Novice	29	7.4
Intermediate	204	51.9
Expert	120	30.5
Advance	40	10.2
Internet experiences		
Novice	34	8.2
Intermediate	212	51.3
Expert	121	29.3
Advance	46	11.1
How to learn IWB		
Myself	203	53.0
Teacher	135	35.2
Other	45	11.7
Frequency of IWB use		
Every class	27	7.9
Only some classes	236	69.0
Once a week	43	12.6
Once a month	36	10.5
Duration of IWB use in a week		
1-5 hours	293	73.6
6-10 hours	81	20.4
11-15 hours	12	3.0
16-20 hours	12	3.0
Which courses		
Linguistic-related courses	325	82.7
Science-related courses	68	17.3

Table II.
Descriptive statistics of the participants

already given tablets and their classrooms were equipped with the technological devices. FATİH project process had been run in the school for three months. The size of classes differed from grade to grade; however, it was around 25-30 students The IWB had been used for three months and the teachers mostly used the IWB and allowed their students to use it. Even tough tablet PC was available at the school, it could not be used because of insufficient learning content on the closed system of the tablet PC and there was no interaction between IWB and the tablet PC. The researchers administrated the

questionnaires to the classroom and the IWB questionnaires were responded by volunteer students ($n = 418$) in 20 minutes.

Data collection

The data collection instrument which was used in this study was composed of two parts. The first part was a questionnaire which consisted of items related to students' personal and academic information. The second part was a survey which had 21 items related to the each of the constructs included in the model. The survey items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). These 21 statements took part under the five constructs and developed based on previous literature and were adapted from Šumak *et al.* (2011), Kılıç and Gökdaş (2014) for the first three points and fourth point, respectively, for the current study:

(1) Perceived usefulness (PU – four items);
(2) Perceived ease of use (PEOU – three items);
(3) Attitudes toward use (ATU – three items);
(4) Perceived learning (PL-six-items) was adapted from; and
(5) IWB-self-efficacy (IWBSE-five items).

The first three factors of 21 items developed by Šumak *et al.* (2011), which was supposed to examine MOODLE usage with TAM, were adapted into context of IWB and TAM by the researchers. The fourth factor (Kılıç and Gökdaş, 2014) was used for measuring PL from blogs. The factor was consists of seven items originally but was revised into six items by omitting the item which was directly related to blogs. The last factor was developed by the researchers by deriving questions from the related literature. The five items were chosen among those questions by consulting with three experts in the field.

Data analysis

SEM is a multivariate method composed of factor and multiple regression analysis to estimate dependency relationships. Technically, the SEM estimates unknown coefficients taking place in linear structural equations set. In the equation system, directly observed variables and latent variables, which are related to observed variables but not observed, usually take place. SEM assumes that there is a causal structure among the latent variables set and observed variables are the explanatory of the latent variables (Byrne, 1998; Hayduk, 1987; Joreskog and Sorbom, 2001). SEM is followed with the Maximum Likelihood estimation method. Therefore, a confirmatory factor analysis (CFA) is carried out to evaluate the reliability and validity of the measurement scales of all variables included in the proposed model. Once the measurement model is validated, the causal model of the structural equation is presented.

Findings

Fit criteria of the model were calculated as $\chi^2/df = 2.48$; RMSEA = 0.060; NFI = 0.96; CFI = 0.98; RFI = 0.96; and AGFI = 0.89. A review of the fit criteria shows that the model remains within acceptable limits (for model-fit criteria, see Schermelleh-Engel *et al.*, 2003; Byrne, 1998; and Joreskog and Sorbom, 2001). All these statistics supported the overall measurement quality for the constructs utilized in this study. It is indicated

that, if root mean square error of approximation (RMSEA) value is equal or lower than 0.05, it means a good fit. On the other hand, if it is between 0.05 and 0.08, it shows sufficient fit level. In this study, RMSEA was found to be sufficient. Normed fit index (NFI) gets values between 0 and 1. The higher the value of NFI, the better the fit index is going to be. The value of 0.96 shows a very good fit. Comparative fit index (CFI) also gets values between 0 and 1. The value of 0.98 shows a very good model fit based on an independent model (Celik, 2009). Adjusted goodness-of-fit index (AGFI) with a value of 0.98 shows well fit. Additionally, the composite/construct reliability (CR) and the average variance extracted (AVE), as presented by Fornell and Larcker (1981), were calculated to determine whether the measurement variable was representative of the related construct. CR is a reliability measure based on the square of the total factor loadings for a construct. AVE represents the overall amount of variance in indicators accounted for by a construct. All AVEs (Table III) were 0.05 or higher, and exceeded the cutoff value of 0.050 (Fornell and Larcker, 1981), and all CRs were 0.73 or higher and exceeded the cutoff value of 0.70 (Nunnally and Bernstein, 1994). These results supported the convergent validity of each of the constructs involved in the research model of this study.

Table III. Confirmatory factor analysis

Latent variables/items	Standard factor loading	*t*-value	CR (> 0.70)	AVE (> 0.50)
IWBSE				
IWBSE1	0.59		0.80	0.50
IWBSE2	0.66	10.27		
IWBSE3	0.73	10.88		
IWBSE4	0.74	11.03		
IWBSE5	0.66	10.28		
Perceived Ease of Use (PEOU)				
PEOU1	0.78		0.83	0.63
PEOU2	0.80	15.91		
PEOU3	0.79	15.76		
Perceived Usefulness (PU)				
PU1	0.75		0.74	0.56
PU2	0.69	13.31		
PU3	0.78	15.02		
PU4	0.78	15.07		
Perceived Learning (PL)			0.83	0.50
PL1	0.63			
PL2	0.74	12.17		
PL3	0.74	12.19		
PL4	0.64	10.88		
PL5	0.67	11.22		
PL6	0.62	10.62		
Attitude (AT)			0.73	0.51
AT1	0.54			
AT2	0.78	9.99		
AT3	0.73	9.74		

The structural model and hypotheses were tested by examining path coefficients and their significance at the level of 0.05. Path coefficient was determined by calculating correlations among constructs proposed in the model. As presented in Table IV, all hypotheses formulated within the scope of the research model were statistically confirmed. *H1*, which assumed that IWBSE had a positive impact on PL, was found to be statistically significant. The impact of IWBSE on PL was 0.61 which means that if IWBSE increases one unit, the impact on PL will be an average of 0.61 points. The relationship between IWBSE and PEOU was statistically significant. IWBSE mostly affected by PEOU ($\beta = 0.51$, $t = 7.92$). The impact of IWBSE on PEOU was 0.51 which means that a 1-point increase in IWBSE leads to 0.51-point increase in PEOU (*H2*). In addition, the relationship between IWBSE and PU latent variables were statistically significant ($\beta = 0.16$, $t = 2.43$). Even though the relationship between these two constructs is significant, the relationship is low (*H3*). The relationship between PL and PEOU was statistically significant. PL was mostly affected by PU ($\beta = 0.63$, $t = 7.94$), and the impact of PL on PU was 0.63 which means that a 1-point increase in PL leads to 0.63-point increase in PU (*H4*). The relationship between PL and PEOU was found significant ($\beta = 0.27$, $t = 3.95$) (*H5*).

The relationship between PEOU and ATU (*H6*) was also validated ($\beta = 0.34$, $t = 5.35$). *H7*, which claimed that there would be a positive significant relationship between PU and ATU, was confirmed ($\beta = 0.58$, $t = 7.47$). The impact of PU on ATU was 0.58, which implies that when PU increased one unit, the impact on ATU will be an average of 0.58 points. Latent variable IWBSE caused the variation in attitude by 38 per cent. In addition, latent variables PL and IWBSE caused the variation in PU by 54 per cent. PEOU and PU latent variables caused the variation in attitude by 64 per cent. Latent variables PL and IWBSE caused the variation in PEOU by 50 per cent. Results of the research model are given in Figure 2.

Hypothesis	Effects	Path coefficient	*t*-value	Remarks
H1	IWBSE→PL	0.61	7.92	Supported
H2	IWBSE → PEOU	0.51	6.59	Supported
H3	IWBSE → PU	0.16	2.43	Supported
H4	PL → PEUO	0.27	3.95	Supported
H5	PL → PU	0.63	7.94	Supported
H6	PEOU → AT	0.34	5.35	Supported
H7	PU → AT	0.58	7.47	Supported

Table IV. Hypothesis coefficients of the research model

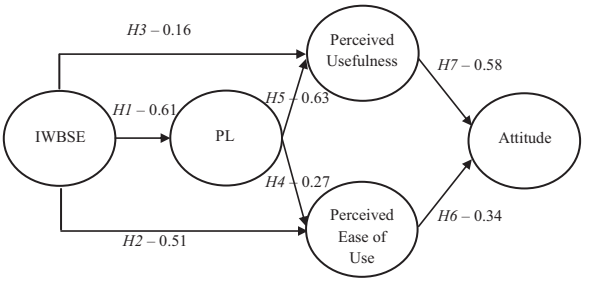

Figure 2. The research model results

Conclusions and discussion

It is aimed to transform all classes into computerized classes (Smart Class) around Turkey with FATIH project which includes usage of interactive whiteboards. Because it is a very big project funded by the government, it is important to evaluate its adaptation among teachers and students. Therefore, the current study aims to investigate the factors which might affect the attitude to use IWBs by high-school students. TAM was used in this investigation. The results showed that most of the students learned how to use IWBs by themselves. On the other hand, the Ministry of Education had teachers to take in-service training on IWBs; however, studies (Pamuk *et al.*, 2013; Türel, 2012; Tatli and Kılıç, 2013) showed that these trainings were not sufficient. Hillier *et al.* (2013) carried out a study with participants from several countries. They stated that participants from Turkey were the least confident in line with their responses to the IWB questionnaire. These results and statements implies that the teachers IWB use skills are not good enough; therefore, the students are bound by this limitation or they have to train themselves which is not a healthy situation where there are in-service trainings for the teacher but not for the students. Therefore in-service training programs which are conducted by the ministry should be examined and revised to train the teachers with sufficient qualifications. Such teachers can affect students in a positive way to increase their self-efficacy and their PL.

Hillier *et al.* (2013) indicated that the teachers from Turkey do not allow their students to use IWBs. Shenton and Pagett (2008) denoted that teachers do not give enough opportunities to their student to interact with IWBs. Glover *et al.* (2003) stated that the students are not confident enough to use IWBs, and if they spent more time with IWBs and have some experiences, their confidence would improve. Using IWBs in classrooms can increase students' social interactions and improve their learning process as well (Türel and Demirli, 2010). Findings of the present study show that the students' IWBSE have a significant effect on their PL so that if their IWBSE increases their PL increases as well. An important portion (38 per cent) of changes in PL is explained by perceived self-efficacy alone. Therefore, teachers should encourage and guide their students to use, interact and have experiences with IWBs to facilitate improvement of their self-efficacy. Improvement in self-efficacy may lead to improvement in learning process and acceptance of new technologies. The relationship among computer self-efficacy, PU and PEOU was found significant, and this result was consistent with the literature (Igbaria *et al.*, 1995; Ramayah and Ignatius, 2005; Stoel and Lee, 2003).

It is determined that PL of the students has a significant and positive relationship both with PU and PEOU. While PL of the students increases the PU and the PEOU increase as well. One-point increase in the PL reflected 0.63 points increase in the PU. In another word, the students' evaluation of their experiences with IWBs makes their beliefs in usefulness of IWBs stronger. Because there are no studies that examine the effect of PL on attitudes for IWB, this result brings a contribution to the field. In addition, this is also a practical implication for FATIH project to develop strategies (such as developing rich learning contents) to increase PL from IWBs which affect PU, PEOU and attitude.

To conclude with, it is determined that, while the students self-efficacy increases, their PL increases as well. Therefore, the teacher should prepare different activities and give students more opportunities for using IWBs, to help them improve their

self-efficacy. Also, it is shown that, while the PL increases, the students find IWBs more useful. To summarize the model and results of the study, perceived self-efficacy, PL, PU and PEOU explain attitude toward IWB.

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Corresponding author

Eylem Kilic can be contacted at: keylem@gmail.com