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What drives students' intention to use tablet computers: An extended technology acceptance model

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ABSTRACT

This study proposed an extended technology acceptance model (TAM) to examine students' intention to use tablet computers in K12 settings. The participants were 347 middle school students who were engaged in a tablet-based instructional initiative. We used the partial least squares (PLS) approach to test the relationships between perceived usefulness (PU), perceived ease of use (PEOU), attitude, intention to use, self-efficacy, technology anxiety, and family support. The results suggested that the extended TAM offered a good explanation of tablet computers acceptance of K12 students. Findings from this research not only inform the successful practice of educational technology initiatives but also lay the foundation for future research.

1. Introduction

The integration of tablet computers into K-12 settings is a lasting interest of educators and researchers, due to the decreasing costs of the physical devices and the increasing availability of wireless connection in schools. Tablet computers make the delivery of instructional materials to students much more convenient than ever before and afford a wide range of online tools for instructors to design teaching activities. In addition, tablet computers nowadays are featured with advanced functions, such as touch screen input, handwriting recognition, text-to-speech, and built-in recreational games, which are attractive to students who grow up in the digital age (Johnson, 2013). Motivated by these advanced and interactive features of tablet computers, students can improve their writing, reading, and math abilities (Patchan & Puranik, 2016). For instance, Kondo et al. (2012) found that students who used tablet computers to assist their language learning spent more time on learning tasks, had higher levels of satisfaction, as well as achieved better performance than those who did not use tablet computers. The benefits of tablet computers bring a growing interest in the use of tablet computers in K-12 education (Mulet, Van de Leemput, & Amadieu, 2019).

It is noteworthy that the prerequisite for fulfilling the benefits of tablet computers in students' learning is that they indeed accept and use tablet computers. Students will not use tablet computers unless they perceive a sense of usefulness and feel comfortable with the technology. The last three decades have seen the emergence of some frameworks to study students' technology acceptance and use. Technology acceptance model (TAM) is 'one of the simplest, easiest to use, and most powerful computer usage models' (McFarland & Hamilton, 2006, p 428). TAM proposed that two variables of perceived ease of use (PEOU) and perceived usefulness (PU) affect students' attitude towards using a new application, system or technology, and then students' attitude ultimately influences their behavioral intention to use. However, researchers reported repeatedly that the TAM explained only a fraction of variances in students' intentions to use new computer applications or technologies. As pointed out by McFarland and Hamilton (2006), researchers who used TAM to understand students' technology adoption process were only able to explain between 45 % and 57 % of

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the variance at its most.

The purpose of this study is to enhance a comprehensive understanding of factors that may influence students' intention to use tablet computers using an extended TAM framework. Specifically, we considered self-efficacy and technology anxiety as two antecedents of TAM as students used a tablet-based educational initiative (i.e., electronic schoolbag) for learning in classroom settings. We also introduced the factor of family support into our extended TAM framework. This research extends the literature on students' intentions to use tablet computers for learning by (1) examining students' technology acceptance of tablet computers, psychological reactions (i.e., self-efficacy and technology anxiety), and family support simultaneously into one study, (2) situating such examination into a specific interactive learning environment which promotes the comparison and generalization of relevant research. The latter consideration is crucial since some studies muddled the TAM related research as they examined students' technology acceptance when the system/technology-rich environment was not implemented, or the students had not accumulated hands-on experiences yet (King & He, 2006). This study could contribute to our theoretical understanding of variables that influence students' adoption of tablet computers and inform practitioners by identifying effective intervention strategies to improve adoption rates of tablet computers.

2. Literature review

2.1. Research on students' technology acceptance of tablet computers

We performed a selective review of research on students' technology acceptance of tablet computers to understand where we have been and where to next. These studies are by no means exhaustive, but they do provide an image of representative studies in the area. As displayed in Table 1, there are two lines of research in the literature pertaining to students' technology acceptance of tablet computers. One set of studies focus on examining students' attitude and perception of tablet computers using qualitative methods or descriptive statistics (Clarke & Abbott, 2016; Dündar & Akçayir, 2014; Ferguson, 2017; Pruet, Ang, & Farzin, 2016). The second set of studies attempt to understand students' acceptance of tablet computers with theoretical frameworks, such as technology acceptance model (TAM), the unified theory of acceptance and use of technology (UTAUT), and the theory of reasoned action (TRA) (Cacciamani et al., 2018; Gokcearslan, 2017; Ifenthaler & Schweinbenz, 2016; Kim & Jang, 2015; Palincsar, Fitzgerald, Marcum, & Sherwood, 2018; van Deursen, Ben Allouch, & Ruijter, 2016). Moreover, the table shows that TAM is a widely adopted framework to examine students' technology acceptance of tablet computers in the literature.

Technology acceptance model (see Fig. 1) is an information systems theory proposed by Davis (1989) to investigate the impact of external variables (i.e., characteristics of a new system or technology) on user's internal beliefs, attitudes, and intentions (Legrisa, Inghamb, & Collerette, 2003). It proposes that PEOU and PU are the two key factors in explaining user's technology acceptance of a new system or technology. Specifically, PEOU is the degree of belief that using a specific technology will be free of effort (Davis, 1989). PU is explained as the degree of belief that using a specific technology would enhance his or her performance (Davis, 1989). PEOU and PU directly influence users 'attitude towards using (AT) and behavioral intention to use (BI). Meanwhile, PEOU and PU play a mediating role in the relation between external variables and the probability of technology use (i.e., AT, BI, and actual use). However, the components of TAM and their relations are not powerful enough to predict the technology acceptance behaviors of students with various characteristics (Nikou & Economides, 2017; Sung, Chang, & Liu, 2016). For instance, some students may feel confident with digital technology while others are reluctant to use technologies in learning because of technology anxiety. In the latest attempts to better explain students' technology acceptance behaviors, researchers focus on integrating the antecedents of PEOU and PU in the TAM (Agudo-Peregrina, Hernández-García, & Pascual-Miguel, 2014; Lai, 2018).

Researchers have reached a consensus that two promising additions to TAM were the concepts of self-efficacy and technology anxiety (Abdullah & Ward, 2016; McFarland & Hamilton, 2006). Self-efficacy is an individual's self-judgment of personal capability to accomplish a specific task (Li & Zheng, 2018a,b; Bandura, 1982). Technology anxiety refers to an individual's tendency to be uneasy, apprehensive, or fearful about using digital technology currently or in the future (Igbaria & Parasurarnan, 1989). However, few studies have examined the effects of self-efficacy and technology anxiety simultaneously on students' technology acceptance in the context of K-12 students using tablet computers to assist learning in classrooms. Besides, the factor of family support was often overlooked in TAM studies (Abdullah & Ward, 2016). Considering that digital learning has become family routines (Gee, Siyahhan, & Cirell, 2016), parents are concerned about their children's technology-based learning or technology acceptance behaviors (Plowman & McPake, 2013). There is already emerging evidence supporting that family-related factors influenced student' perception towards tablet computers (Dündar & Akçayir, 2014). In the following sections, we discuss the influences of self-efficacy, technology anxiety, and family support on students' technology acceptance towards tablet computers.

2.2. Self-efficacy

Self-efficacy refers to one's own belief to execute an action or perform a task according to specific situations (Bandura, 1982). In e-learning, computer self-efficacy refers to students' self-confidence in their capability to seek for information and their skill with the use of computers (Agudo-Peregrina et al., 2014). Self-efficacy has been considered as an antecedent of PEOU and PU in many studies (Grandon, Alshare, & Kwun, 2005). With regard to the relationship between self-efficacy and PEOU, a meta-analysis of 41 studies revealed that self-efficacy positively predicted PEOU (Abdullah & Ward, 2016). However, the relationship between self-efficacy and PU was inconsistent in the literature. Among the 41 studies, only ten studies found a positive relationship between self-efficacy and PU, while 17 indicated no significant association between the two constructs (Abdullah & Ward, 2016). Considering that computer

Table 1
A selective review of research on students' technology acceptance of tablet computers.

Article	Variable	Theory	Sample	Method
Pruet et al. (2016)	Technology experience, learning style, attitude	NA	213 grade 2 students	t test, logistic regression
Clarke and Abbott (2016)	Students 'experience and perceptions about tablet computers	NA	27 primary students	Interview
Dündar and Akçayir (2014)	Attitudes and opinions towards tablet computers	NA	206 secondary students	Mixed Method
Ferguson (2017)	Experiences and perceptions towards tablets use with a focus on gender and grade	NA	676 middle school students	Descriptive Statistics
Palincsar et al. (2018)	The role of the teacher, the device, the peers in scaffolding student learning	Metacognitive scaffolding	A class of grade 6 students	Case study
Cacciamani et al. (2018)	PU, PEU, affects, support conditions, empowerment in learning	TAM & UTAUT	296 secondary students	Path analysis
Gokcearslan (2017)	PU, PEU, intention to use	TAM & self-directed learning	414 high school students	Descriptive Statistics
Ifenthaler and Schweinbenz (2016)	Attitude, performance expectancy, social influence, self-efficacy	TAM, UTAUT, and TRA	120 secondary students	Regression
Kim and Jang (2015)	PU, PEOU, self-efficacy, desire for learning, satisfaction	TAM	277 primary students	Partial least square
van Deursen et al. (2016)	PU, PEU, interests, social influence, prior experience	TAM & UTAUT	139 primary students	Mixed Method

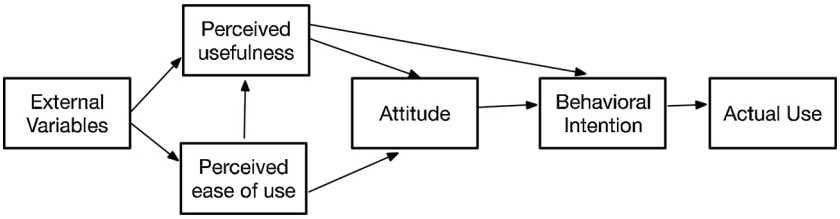

Fig. 1. Technology Acceptance Model (Davis, 1989).

self-efficacy conveys the idea of students' ability in using tablets for learning, it is hypothesized to have a positive relationship with PU in our study. In sum, the first two hypotheses were developed as below:

H1. Self-efficacy will positively predict the perceived usefulness of tablet computers.

H2. Self-efficacy will positively predict perceived ease of use of tablet computers.

2.3. Technology anxiety

Technology anxiety refers to all digital technology-related negative emotions or feelings, is another commonly used antecedent factor in TAM (Abdullah & Ward, 2016). In the current study, technology anxiety is students' negative emotions or feelings to tablet computers even before they actually use it. Technology anxiety stems from the construct of computer anxiety. Computer anxiety happens due to the lack of prior experience or self-confidence in effectively controlling computers (Oyedele & Simpson, 2007). For this reason, individuals who are anxious about using specific digital technology are more likely to be reluctant to adopt it for learning (Al-Alak & Alnawas, 2011). Previous research has already revealed that technology anxiety can negatively affect PEOU (Ali, Ahmed, Tariq, & Safdar, 2013; Saadé & Kira, 2006; van Raaij & Schepers, 2008) and PU (Purnomo & Lee, 2012; Roberts & Henderson, 2000). In accordance with prior research, we, postulated a negative relationship between technology anxiety and PEOU, as well as between technology anxiety and PU. Thus, the following hypotheses were added:

H3. Technology anxiety will negatively predict the perceived usefulness of tablet computers.

H4. Technology anxiety will negatively predict perceived ease of use of tablet computers.

2.4. Family support

Technology acceptance research has traditionally emphasized the effects of social influence on students' attitude and effort toward digital technology. Social influence describes the degree to which students perceive the view of important others, including peers, teachers, and parents (Venkatesh, Morris, Davis, & Davis, 2003). Prior studies found social influence did not have an effect on students' attitude toward tablet computers (Ifenthaler & Schweinbenz, 2016; van Deursen et al., 2016) because the overall positive view of people neutralize the effect of social influence. However, not all people perceived tablet computers as a positive tool. Parents, different from the peers and teachers of students, have more concerns about students' physical health (e.g., eyesight, posture, and hearing). Parents may hold diverse attitude toward tablet computers weighing between the potential negative physical effects and positive learning benefits (Dündar & Akçayir, 2014). However, the support of families was often overlooked in most empirical studies.

As various kinds of technologies permeated into every aspect of modern life, it is deemed necessary to consider the influence of family support in the adoption of new systems or technologies by students. Family support, in a broad sense, means the resources and supports provided by parents to their children in order to enhance the latter's growth and development. In the context of using tablets for learning, we defined family support as parents' supportive attitude and actions as their children try to use tablet computers to accomplish learning tasks or activities. Parents who hold a positive attitude towards tablet computers may provide hands-on guidance and answers to questions from their children. Meanwhile, some parents may have hesitations about tablet-based learning. As a result, those parents prevent children from using tablet computers at home since they were afraid that children might be addicted to irrelevant information or computer games (Morgan, 2010; Takeuchi, 2011). The diverse attitudes and facilitating or regulating actions of parents undoubtedly affect the adoption of tablet computers by their children (Dündar & Akçayir, 2014). We posited family support positively affects students 'technology acceptance, including PU, PEOU, attitude, and intention to use. Therefore, the following hypotheses were formulated:

H5. Family support will positively predict perceived usefulness of tablet computers.

H6. Family support will positively predict perceived ease of use of tablet computers.

H7. Family support will positively predict students' attitude towards using tablet computers.

H8. Family support will positively predict students' intention to use tablet computers.

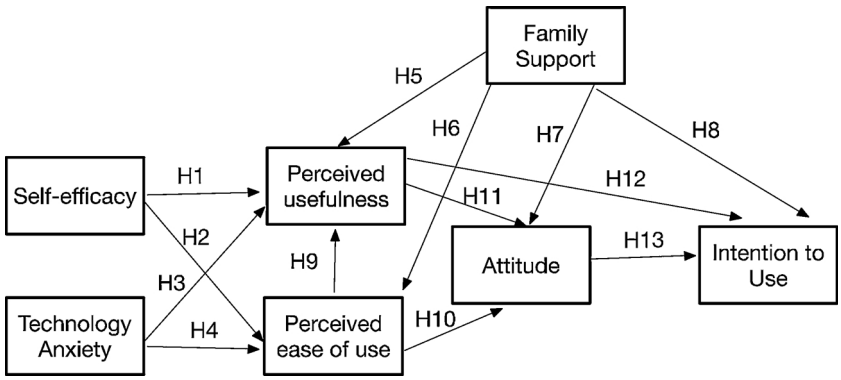

Fig. 2. An extended technology acceptance model with hypotheses.

3. Towards an extended technology acceptance model

A wide range of studies have used TAM as a framework to investigate the continuance intention of learners towards using massive online open courses (MOOCs) (Wu & Chen, 2017), e-learning systems (Bhatiasevi, 2011; Park, Son, & Kim, 2012), mobile learning (Park, Nam, & Cha, 2012), social media (Doleck, Bazelais, & Lemay, 2016), e-books (Jin, 2014), e-portfolios (Abdullah & Ward, 2016), and online courses (Arbaugh & Duray, 2002; Selim, 2003). However, studies vary radically in how they expanded or modified TAM for a better explanation of learners' intention to accept and use innovative educational technologies, depending on the researchers' goals, the types and the design features of educational innovations (Liu, Chen, Sun, Wible, & Kuo, 2010; Nikou & Economides, 2018). In the context of tablet-based learning, researchers have extensively examined the influences of teachers' attitude (Blackwell, Lauricella, & Wartella, 2016; Montrieux, Vanderlinde, Courtois, Schellens, & De Marez, 2014), students' characteristics (Couse & Chen, 2010; Duran, 2016; Johnson, 2013; Patchan & Puranik, 2016), and students' previous experiences (Park, Nam et al., 2012) on an individual's technology acceptance. However, few studies have investigated the role of family support in students' technology adoption process. Moreover, the constructs of self-efficacy and technology anxiety are two most common antecedents of PEOU and PU in recently developed acceptance models; Nevertheless, mixed results existed in the literature pertaining to the relationships between the two antecedents, PEOU, and PU (Abdullah & Ward, 2016).

In this study, we proposed an extended TAM in which family support is supposed to have an influence on students' internal beliefs, attitudes, and intentions. We also included self-efficacy and technology anxiety in our extended TAM model to add more empirical evidence. The hypothesized model is depicted in Fig. 2. As aforementioned, we developed eight hypotheses with regard to the relationships between the components of TAM and the variables of interest, i.e., family support, self-efficacy, technology anxiety.

In addition, the hypothesized model viewed the relationships between PU, PEOU, attitude, and intention to use the same as the original TAM developed by Davis (1989) which has been demonstrated by many other studies. To be specific,

H9. Perceived ease of use will positively predict perceived usefulness.

H10. Perceived ease of use will positively predict attitude towards using tablet computers.

H11. Perceived usefulness will positively predict attitude towards using tablet computers.

H12. Perceived usefulness will positively predict intention to use tablet computers.

H13. Students' attitude towards using tablet computers will positively predict their intention to use tablet computers.

4. Methods

4.1. Participants and procedure

Seventh-grade students (N = 347) from a public middle school in Southeast China volunteered and consented to participate in this study. Participants were comprised of 207 male and 140 female students, with their ages ranging from 11 to 13 years old. A tablet-based learning environment of the electronic schoolbag, also known as eSchoolbag (Li & Zheng, 2017; 2018a,b), was first introduced to the participants. Then students played with the tablets to familiarize themselves with this new type of learning technology during regular school classes. Immediately afterward, students were asked to finish a questionnaire regarding their PU, PEOU, self-efficacy, technology anxiety, and family support.

4.2. The tablet-based learning environment

The tablet computers used in our study refers to the eSchoolbag, which provide students an individualized learning environment.

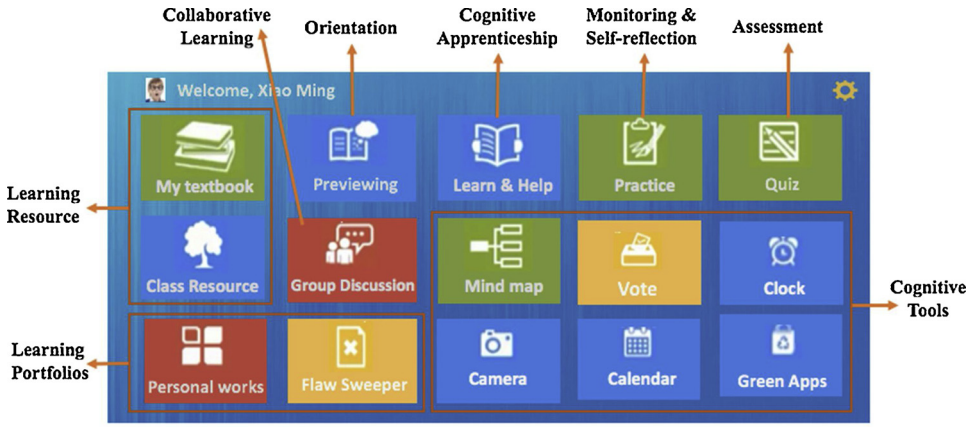

Fig. 3. The interface of the tablet computer (Li & Zheng, 2017).

The eSchoolbag is a purposely designed tablet computer system for K-12 students (Li & Zheng, 2017; Zheng, Li, & Zheng, 2017). The eSchoolbag differs with other tablet computers by allowing both teachers and parents to monitor and control students' learning in real-time. In the system, students can have access to learning resources, scaffoldings, cognitive, and metacognitive tools that were specifically designed for them. But students have limited access to open-source applications so that they will not get addicted to online shopping or irrelevant games. As displayed in Fig. 3, students can obtain learning resources from *My Textbook* and *Class Resource,* which are uploaded by their teachers. Students can also evaluate their learning achievements using *Practice* and *Quiz,* receive scaffoldings by seeking for help from *Learn & Help,* control and monitor learning processes with the functions of *Previewing* and *Flaw Sweeper*. Furthermore, the tablet-based eSchoolbag provides students various cognitive tools such as mind map, vote, timer, calendar, camera, and external green apps. In essence, learning in the eSchoolbag environment is a unique experience for students since they self-regulate their learning processes on the one hand, but the process of self-regulated learning is simultaneously monitored by teachers on the other hand. Examining students' technology acceptance of this type of tablet computer would clarify factors promoting or impeding the successful application of the eSchoolbag initiative.

4.3. Instruments

Students' perceptions of technology acceptance, self-efficacy, technology anxiety, and family support were obtained through a self-reported questionnaire. Specifically, eight items measuring *perceived ease of use* and *perceived usefulness* were adapted from the research of Davis (1989). A sample item of *perceived usefulness* was 'The tablet-based eSchoolbag can help improve my learning efficiency.' With regard to *attitude towards using tablet computers* and *intention to use tablet computers*, five items adapted from Chu, Hwang, Tsai, and Tseng's scale (2010) were used to measure each of the two constructs. There were also five items adapted from Liu's (2010) study to measure *technology anxiety,* as well as *self-efficacy*. The sample items were 'I feel a lot of pressure when using tablet computers for learning' and 'I am sure I can do well on the tasks in this environment,' respectively. Besides, three items were developed to measure *family support*, whose content validity was verified by two experts. A sample item of *family support* was 'My parents monitor how I used tablet computers.' All items were presented using a five-point Likert scale with one stands for 'strongly disagree' and five as 'strongly agree.' The description of the variables is demonstrated in Table 2.

4.4. Analysis

We used structural equation model (SEM) to test the reliability and validity of our constructs (i.e., construct reliability, convergent validity, and discriminant validity) and the aforementioned hypotheses. Specifically, partial least squares (PLS) approach was performed in WrapPLS (6.0) software (Kock, 2017). Following the guidelines proposed by Hair, Celsi, Money, Samouel, and Page (2014),

Table 2
Description of the constructs.

Construct	Variable	Description
Perceived Usefulness	PU	The degree to which a person believes that tablet computers would enhance his performance
Perceived Ease of Use	PEOU	The degree to which a person believes that using tablet computers will be free of effort
Family support	FAM	The degree of family support of using tablet computers
Attitude toward using tablet computers	ATT	The extent to which user believe that it is a good idea to use tablet computers
Self-efficacy	SE	The belief of completing a task using tablet computers
Technology Anxiety	TA	Apprehension of using tablet computers
Intention to use tablet computers	INT	The likelihood that an individual will use tablet computers

Table 3
The measurement model.

Construct	Items	Loading	Cronbach's Alpha	Composite Reliability	AVE
Perceived Usefulness	PU1	0.911	0.939	0.913	0.794
	PU2	0.898			
	PU3	0.907			
	PU4	0.847			
Perceived Ease of Use	PEOU1	0.903	0.914	0.874	0.728
	PEOU2	0.884			
	PEOU3	0.846			
	PEOU4	0.775			
Family support	FAM1	0.765	0.823	0.678	0.608
	FAM2	0.796			
	FAM3	0.779			
Attitude toward using tablet computers	ATT1	0.837	0.943	0.924	0.768
	ATT2	0.853			
	ATT3	0.909			
	ATT4	0.912			
	ATT5	0.868			
Self-efficacy	SE1	0.822	0.894	0.85	0.63
	SE2	0.670			
	SE3	0.865			
	SE4	0.842			
	SE5	0.755			
Technology Anxiety	TA1	0.898	0.96	0.948	0.829
	TA2	0.932			
	TA3	0.938			
	TA4	0.855			
	TA5	0.929			
Intention to use tablet computers	INT1	0.827	0.93	0.906	0.727
	INT2	0.834			
	INT3	0.825			
	INT4	0.898			
	INT5	0.876			

Note: AVE = average variance extracted.

we constructed two models: a measurement model (i.e., the outer model) and a structural model (i.e., the inner model). The outer model assesses the reliability and validity of all constructs, and the inner model estimates the relationship between all the constructs. In the next section, we presented the results of both the outer and the inner models.

5. Results

5.1. The measurement model

The measurement model was assessed based on item loadings, construct reliability, convergent validity, and discriminant validity. As demonstrated in Table 3, the item loadings of the seven constructs (i.e., PU, PEOU, self-efficacy, technology anxiety, family support, attitude towards using tablet computers, and intention to use tablets) range from 0.67 to 0.94, which all exceeded the recommended threshold of 0.6 (Stevens, 2002). The reliability of the constructs was also guaranteed since the values of Cronbach's alpha were all above 0.6, a threshold indicating an acceptable internal consistency (Hair, Black, Babin, & Anderson, 2006). Besides, we checked the convergent validity of the constructs using the parameter of average variance extracted (AVE). The results in Table 3 showed that the values of AVE were all above the minimum value of 0.5 (Fornell & Larcker, 1981). AVE was also used to check discriminant validity by verifying that the correlation coefficients between two constructs were smaller than the square root of each construct's AVE following Fornell and Larcker's (1981) criterion. Table 4 presented that all the correlations were less than the square root of AVE (the diagonal of Table 4). Furthermore, the model fit indices all met the suggested criterion are shown in Table 5. Based on these facts, we can conclude that the measurement model is satisfactory.

5.2. Structural model

The structural model was tested with path coefficients, significance values (p), coefficient of determination values (R^2), effect size

Table 4
Discriminant validity check.

Constructs	PU	PEOU	FAM	ATT	SE	TA	INT
PU	**0.891**	0.584	0.428	0.573	0.530	−0.055	0.712
PEOU	0.584	**0.853**	0.281	0.280	0.455	−0.060	0.561
FAM	0.428	0.281	**0.780**	0.355	0.399	−0.043	0.456
ATT	0.573	0.280	0.355	**0.876**	0.478	0.022	0.538
SE	0.530	0.455	0.399	0.478	**0.794**	−0.076	0.621
TA	−0.055	−0.060	−0.043	0.022	−0.076	**0.911**	−0.035
INT	0.712	0.561	0.456	0.538	0.621	−0.035	**0.852**

Table 5
Model fit indices.

Model fit indices	Values	Recommended Criterion
Average path coefficient (APC)	0.248, P < 0.001	Acceptable if P < .05
Average R-squared (ARS)	0.424, P < 0.001	Acceptable if P < .05
Average adjusted R-squared (AARS)	0.419, P < 0.001	Acceptable if P < .05
Average block VIF (AVIF)	1.369	Acceptable if < = 5, ideally < = 3.3
Average full collinearity VIF (AFVIF)	1.832	Acceptable if < = 5, ideally < = 3.3
R-squared contribution ratio (RSCR)	1.00	Acceptable if > = 0.9, ideally = 1
Simpson's paradox ratio (SPR)	1.00	Acceptable if > = 0.7, ideally = 1

(η^2), and predictive relevance (Q^2) (Akter, Ambra, & Ray, 2011). As displayed in Table 6, all the hypotheses in the proposed model were supported except H10. Fig. 4 illustrated all the significant paths with determination values (R^2). Intention to use tablet computers was found to be significantly affected by family support, perceived usefulness, and attitude to use tablets. The latter three variables accounted for 55 % of the variance in the intention to use tablet computers. This is an acceptable level of variance following the rule of Warner (2012) who considered the R^2 values between 0.4 and 0.7 as adequate. Besides, we found that self-efficacy, technology anxiety, family support, and perceived ease of use accounted for 49 % of the variance in perceived usefulness. Attitude to use tablets was significantly influenced by family support and perceived usefulness, with the latter two variables accounting for the variance of 39 % in the prior one. In addition, we tested the effect size of all significant relationships in the hypothesized model. We considered the thresholds of 0.02, 0.15, and 0.35 as small, medium, and large effect respectively, following the rules proposed by Cohen (1992). The results in Table 6 indicated a large effect size with H12, medium effect size with H2, H9 and H11, small effect size with the rest of the hypotheses.

5.2.1. Self-efficacy and TAM

Hypothesis 1 and 2 were related to the relationships between self-efficacy and TAM. Self-efficacy positively predicted both perceived usefulness (H1: $\beta = 0.213$, $p < 0.001$, $\eta^2 = 0.114$) and perceived ease of use (H2: $\beta = 0.386$, $p < 0.001$, $\eta^2 = 0.186$).

5.2.2. Technology anxiety and TAM

The relationships between technology anxiety and TAM were explored in Hypothesis 3 and 4 positing that technology anxiety could negatively affect perceived usefulness and perceived ease of use. Our results confirmed these two hypotheses with technology anxiety negatively predicting both perceived usefulness (H3: $\beta = -0.102$, $p = 0.027$, $\eta^2 = 0.031$) and perceived ease of use (H4: $\beta = -0.155$, $p < 0.002$, $\eta^2 = 0.047$).

Table 6
Structural model hypotheses.

Construct	Path	Path coefficients	P value	Supported	η^2
H1	SE- > PU	0.213	< 0.001	Yes	0.114
H2	SE- > PEOU	0.386	< 0.001	Yes	0.186
H3	TA- > PU	−0.102	0.027	Yes	0.031
H4	TA- > PEOU	−0.155	0.002	Yes	0.047
H5	FAM- > PU	0.244	< 0.001	Yes	0.108
H6	FAM- > PEOU	0.114	0.016	Yes	0.032
H7	FAM- > ATT	0.156	0.002	Yes	0.057
H8	FAM - > INT	0.156	0.002	Yes	0.072
H9	PEOU- > PU	0.397	< 0.001	Yes	0.235
H10	PEOU- > ATT	0.038	0.237	No	0.012
H11	PU- > ATT	0.546	< 0.001	Yes	0.320
H12	PU- > INT	0.552	< 0.001	Yes	0.395
H13	ATT- > INT	0.158	0.001	Yes	0.086

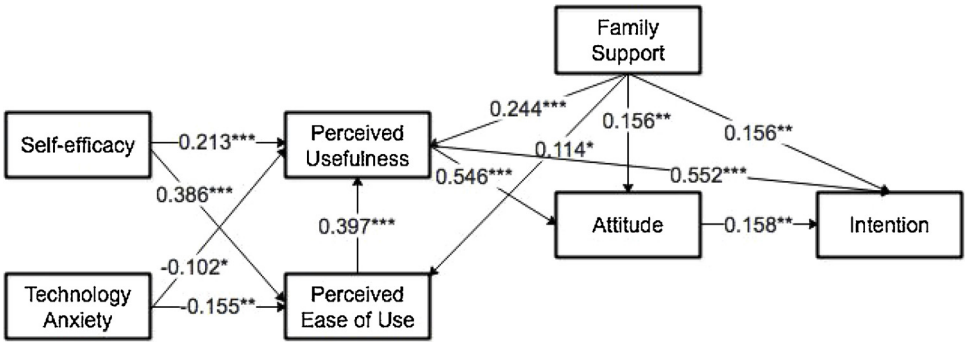

Fig. 4. The structural model.
Note. *p < 0.05; **p < 0.01; ***p < 0.001

5.2.3. Family support and TAM

Hypotheses 5–8 dealt with the relationships between family support and TAM, which assumed that family support could positively predict perceived usefulness, perceived ease of use, attitude and intention to use tablet computers. All of these four hypotheses were supported in this study. Specifically, family support positively predicted perceived usefulness (H5: $\beta = 0.244$, $p < 0.001$, $\eta^2 = 0.108$), perceived ease of use (H6: $\beta = 0.114$, $p = 0.237$, $\eta^2 = 0.032$), attitude (H7: $\beta = 0.156$, $p = 0.002$, $\eta^2 = 0.057$), and intention to use tablet computers (H8: $\beta = 0.156$, $p = 0.002$, $\eta^2 = 0.072$).

5.2.4. Relationships within TAM

Relationships within TAM, namely the relationships between perceived ease of use, perceived usefulness, attitude, and intention to use were addressed in Hypotheses of 9−13. All the hypotheses were supported except Hypothesis 10 (H10: $\beta = 0.038$, $p = 0.237$, $\eta^2 = 0.012$). This result is opposed to the original TAM model developed by Davis (1989); however, this finding corroborates at least three prior studies which claimed that perceived ease of use had no direct effect on students' attitude towards using MOOCs, Smart Watch, and e-learning systems (Mohammadi, 2015; Wu & Chen, 2017; Wu, Wu, & Chang, 2016).

6. Discussions and conclusions

This study found that self-efficacy positively predicted students' perceived ease of use and perceived usefulness of tablet computers in K12 settings. This finding is consistent with most of the previous research (Abdullah & Ward, 2016). Students who think themselves more capable of using tablet computers are more inclined to find tablet computers useful for their study and ease to use. In addition, this study revealed that technology anxiety had a direct negative relationship with either perceived usefulness or perceived ease of use. It is empirically reasonable that students who have apprehension towards using tablet computers would find it harder to recognize the usefulness of tablet computers. The sense of technology anxiety or apprehension could also prevent them from using tablet computers efficiently and effectively. The negative relationships draw our attention towards the importance of students' emotional states which should have been a crucial consideration in the attempt to understand students' technology adoption processes.

Moreover, this study found that family support significantly positively predicted students' perceived ease of use, usefulness, attitude towards using tablets, and intention to use tablet computers. In line with the argument that family matters in the use of technology (Takeuchi, 2011), results from this study added more contextual evidence that family support matters to students' acceptance of tablet computers whereby they engage in a highly interactive environment for learning in classroom settings. It is important to notice that the influence of family support on students' adoption of tablet computers is all-around from a technology acceptance perspective. While researchers and practitioners alike often fail to understand students 'unwillingness to accept new systems/technologies that appear to promise substantial benefits (McFarland & Hamilton, 2006), our study provided new insights towards the resolve of this failure by taking both the contextual factor (i.e. the specific tablet-based learning environment) and family support into consideration (Sung, Hwang, Chen, & Liu, 2019).

While most of the TAM related studies revealed that perceived ease of use directly predicted users' attitudes towards new technology or system, our results suggested that this relationship did not necessarily exist in any contexts and for all populations. One possible reason is that tablet computers nowadays are usually user-friendly, making them no challenges to users at all. As a consequence, perceived ease of use had no direct effect on students' attitude towards using tablet computers in classroom-based learning. Another explanation is that the relationships between perceived ease of use, usefulness, and attitude towards using tablet computers may depend on students' motivational judgments. If students value the use of tablet computers way more important than the factor of ease of use, they may still hold a positive attitude towards tablet computers even though they find those tablet computers are hard to use.

This study has not only theoretical contributions but also practical implications. The crucial role of family support in students' learning has long been recognized in the literature (Plowman & McPake, 2013); however, the influence of family support on students' adoption of new technologies or systems remains an underexplored area of research (Abdullah & Ward, 2016). As suggested by the

results of this study, school administrators and teachers should create opportunities for direct and meaningful interactions with parents, who can get ideas from school on how to support their children in educational technology initiatives. For parents, they need to be proactive in learning about the school "s academic programs, especially those related to students' technology acceptance, in order to facilitate the process of adopting new technology by their children. Furthermore, educational institutions and parents should make a joint effort to improve students' self-efficacy, to reduce their technology anxiety, and to underline the usefulness of the tablet computers to aim for a better performance of students in adopting the tablet-based learning environment.

7. Limitations and future direction

This study proposed an extended technology acceptance model by integrating the constructs of self-efficacy, technology anxiety, and family support into the TAM. Findings from this research not only inform the practice of educational technology initiatives but also lay the foundation for guiding future research. Nevertheless, this study is not without limitations. First, the mechanisms that govern the positive relationships between family support and the intrinsic variables of TAM are still unclear. In the future, qualitative research based on interviews of both students and parents could reveal more facts and explanations of such relationships. Second, it is practically impossible to include everything into the TAM while researchers have been testing other factors such as subjective norm, perceived interaction, and playfulness in TAM-based models. The dilemma of examining as many as possible variables or choosing appropriately contextual variables calls for more empirical studies in future as well. Furthermore, the findings of the study are applicable to the specific tablet computers designed for K-12 students. It is important to replicate this study when students are using general tablet computers. Finally, students' intention to use tablet computers does not equate to their actual use behaviors. Longitudinal research based on system log files to examine student' actual use of tablet computers should be carried out to evaluate the validity of our model, taking into account the changes that students may have after using tablet computers for a period of time.

Declaration of Competing Interest

The authors declare that they have no conflict of interests.

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