Computers & Education 95 (2016) 114–122

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

The effects of secondary teachers' technostress on the intention to use technology in South Korea

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ARTICLE INFO

Article history:
Received 26 March 2015
Received in revised form 9 December 2015
Accepted 17 December 2015
Available online 19 December 2015

Keywords:
Media in education
Pedagogical issues
Secondary education
TPACK
Technostress

ABSTRACT

This study aims to investigate the structural relationships between secondary school teachers' TPACK, perception of school support for technology use, technostress, and intention to use technology in Korea, where a SMART education initiative has been announced recently for K-12 education. The study employed structural equation modeling in order to examine the causal relationships among the variables, and data from 312 secondary school teachers were analyzed. The results indicated that TPACK and school support had significant effects on technostress. In addition, technostress significantly influenced teachers' intentions to use technology. Lastly, technostress significantly mediated TPACK, school support and the intention to use technology.

1. Introduction

Required competencies for learners and teachers have changed in the 21st century. Domain-specific knowledge in addition to 21st century skills are considered important in this digital era. Accordingly, educational researchers and practitioners have tried to develop appropriate educational methods for future learning. Specifically, in Korea, the SMART education initiative has been proposed as a new educational agenda. SMART is an acronym for self-regulated, motivated, adaptive, resource-enriched, and technology-embedded education (Korean Ministry of Education, Science and Technology, 2011). One example of the initiative is the digital textbook project which aims to transform teaching and learning in K-12. According to the SMART education initiative plan, paper-based textbooks in elementary and middle school will be gradually replaced by mobile-based digital textbooks, integrating all existing instructional resources such as textbooks, references, workbooks, and dictionaries in order to provide a personalized learning environment under the facilitation and guidance of competent teachers.

This government-driven educational transformation is in line with the rapid societal change in South Korea. It was reported that 82.5% of the South Korean population were Internet users and 78.5% were smartphone users as of 2012 (KISA, 2012). Given this high rate of technology use in everyday activities, it is not surprising that Korean students won first place for Digital Reading Assessment among 19 participating countries in the PISA (Programme for International Student Assessment) test organized by OECD in 2009. However, neither the widespread use of smartphones nor students' ability to read digital materials guarantees successful integration of technology in education.

Previous research on the use of computers for education already reported that teachers are the key to technology adoption. For example, teachers' computer experiences (Williams, Coles, Wilson, Richardson, & Tuson, 2000), teachers' anxieties or attitudes toward computer use (Shapka & Ferrari, 2003), and teachers' experiences with professional development programs

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http://dx.doi.org/10.1016/j.compedu.2015.12.004
0360-1315/

on computer use (Vannatta & Fordham, 2004) were critical to technology integration. Now, we have the issue of implementing the SMART initiative in South Korea, which is fundamentally similar to computer adoption a decade ago, given that mobile-based digital textbooks represent another type of technology that requires the process of diffusion of innovation. Hence, researchers claim that teachers are still likely to be the key players in this new era when digital textbooks and mobile devices are introduced in classrooms for teaching and learning. If teachers do not buy into the initiative, there can be no further integration of it. There are many studies supporting this claim, investigating the technology acceptance of teachers as one of the major issues in technology integration in the education field (Yuen & Ma, 2008).

Among various relevant factors for technology acceptance, this study brought up the issue of technostress, that is, psychological and physical stress toward technology use, as defined by Brod (1984). Specifically, the SMART initiative in Korea is a government-driven policy and teachers are busy with teaching and managing students in a highly competitive culture. Adopting the new initiative may cause mental stress for teachers in this situation. In psychology, stress is considered to arise from dynamic interactions between the individual and the environment (Matthews, Zeidner, & Roberts, 2004). For example, Lazarus and Folkman (1984) proposed the transactional theory of stress, which explains the processes of coping with stressful events. The individual first appraises the stressor, and then appraises the internal and external resources at his or her disposal. Adopting this framework, the study defined the internal resource that teachers employ as Technological Pedagogical and Content Knowledge, or TPACK, and the external resource surrounding teachers as school support.

Overall, this study investigated the factors affecting teachers' intentions to use technology in South Korea, and the predictors are hypothesized to be teachers' TPACK and school support, mediated by teachers' perceived level of technostress. This study aims to provide an understanding of the psychological perspective for teachers who are expected to adopt new technology. Also, implications for facilitating technology adoption from the standpoint of teachers' internal and external factors are discussed.

2. Theoretical background and hypotheses

2.1. Teachers' technostress

There exists prior research focusing on how to encourage teachers to use technology more actively. However, as some studies have pointed out, there are many obstacles: For example, lack of training, inadequate infrastructure, and lack of support from technology specialists may induce anxiety and tension in teachers, resulting in psychological and physical stress related to technology use. This phenomenon, defined as technostress (Brod, 1984), is currently receiving attention in the educational context as new technologies such as digital textbooks, cloud computing, and interactive technology spread into classrooms. Weil and Rosen (1997) elaborated the concept of technostress, and defined it as "any negative impact on attitudes, thoughts, behaviors or psychology caused directly or indirectly by technology." Although technostress has been given different labels such as computer anxiety and negative computer attitudes (Wang, Shu, & Tu, 2008), it is characterized by the tenseness and anxiety that an individual feels when using technology. This negative emotion should be considered important because it tends to prevent one from further using the technology.

Empirically, recent studies reported that teachers using new technology in classrooms have experienced technostress, which caused adverse effects in the active adoption of technology. For example, Al-Fudail and Mellar (2008) conducted a qualitative research with nine in-service teachers to determine their level of technostress. Observations of classroom teachings and face-to-face interviews revealed that there exists several factors causing technostress such as technological system failure, insufficient technical and social support for technology use, increased time for setting up and preparing class lectures, and inadequate school culture climate for technology adoption. In a similar vein, Lim (2012) reported that teachers' technostress levels increased after adopting digital textbooks in South Korea. He claimed that teachers felt frustrated when technological system failures occurred, because they felt like they were unable to control the situation. Also, the study reported that guidance for teachers on how to integrate digital textbooks into their teaching was limited, increasing teachers' psychological and physical overload for technology adoption.

These prior studies mainly focused on exploring teachers' experiences regarding technostress. It is now time to investigate causal relationships between the selected predictors and teachers' technology use. Since stress is an outcome of the interaction between an individual and the environment, as mentioned above (Matthews et al., 2004), it is necessary to identify individual as well as environmental factors affecting technostress in order to reduce the stress level that teachers may experience during technology integration. To be more specific, according to the transactional theory of stress, there are two types of appraisal: primary appraisal and secondary appraisal. The former is the individual's evaluation of an event or situation, while the latter is the individual's evaluation of his or her ability to handle an event or situation. This evaluation is dependent on whether the individual has the internal and external resources or not. Thus, this study selected TPACK as the teachers' internal resource and school support as the external resource to examine how teachers cope with technostress.

2.2. Factors relevant to technostress

Shulman (1986) claimed that teachers should be equipped with content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK), which is an integration of CK and PK. Later on, Mishra and Koehler (2006) expanded

Shulman's model for TPACK by adding technology knowledge (TK). This expanded model implied that knowledge of content, pedagogy, and technology needs to be integrated to facilitate learning with technology. Mishra and Koehler (2006) reported that teacher training programs covering all three perspectives were effective for teachers to acquire TPACK. Although TPACK was not explicitly mentioned, a study by Kay (2008) reported that an 8-month long teacher training program on computer integration into education significantly reduced teachers' computer anxiety. In other words, the study results indicated that the level of teachers' knowledge on the use of computers affected their level of anxiety regarding computer use.

On the other hand, from the environmental standpoint, school support is gaining attention as a success factor for technology integration (Tondeur, van Keer, van Braak, & Valcke, 2008). School support is defined as teachers' perception of school support in terms of technology use for teaching. Zhao, Pugh, Sheldon, and Byers (2002) proposed human infrastructure, technological infrastructure, and social support as sub-components of school support, while Tondeur, Devos, Houtte, van Braak, and Valcke (2009) divided school support into structural characteristics and cultural characteristics based on a series of studies. In this study, researchers selected technical support in the form of an infrastructure, and peer support in the form of social and cultural support as sub-constructs of school support. Although the importance of school support has been continuously emphasized, empirical evidence is not easily found in recent research. Bradley and Russell (1997) reported that technical support from schools had a significant effect in reducing teachers' computer anxiety, which affected stress related to computer use. Further study on the effects of school support on technology integration, especially teachers' technostress and the use of technology is required to understand current technological changes in education.

2.3. Teachers' intention to use technology

This study selected intention to use technology as a consequence variable for teachers' management of technostress because intention involves the decision on how to behave, according to the technology acceptance model known as TAM (Davis, 1989). The theory on technology acceptance is related to the Theory of Reasoned Action (TRA hereafter) proposed by Fishbein and Ajzen (1975). Claiming that human behavior is predicted by an individual's intention, TRA has been recognized as a reasonable model explaining behavior when using new technology. Grounded in TRA, TAM specifically evaluated individuals' behaviors regarding technology acceptance and elaborated on the concept of behavior as behavioral intention to use and actual use. This study focused on the intention to use, not the actual use of technology, since the digital textbook technology was still in the initiation process and few teachers had actually experienced the specific technology.

Prior research indicated that anxiety or stress regarding technology use had negative effects on the intention to use technology (e.g., Chatzoglou, Sarigiannidis, Vraimaki, & Diamantidis, 2009; Rezaei, Mohammadi, Asadi, & Kalantary, 2008). Regarding predicting variables, Park (2004) reported that school support significantly affected primary and secondary school teachers' intentions of technology adoption for teaching, mediated by perceived usefulness. Shin (2011) also reported that school support influenced primary school teachers' use of technology.

2.4. Research hypotheses

Based on the literature review, this study aimed to investigate structural relationships between factors influencing secondary school teachers' technostress and their intention to use technology for teaching. TPACK and school support were considered critical factors influencing technostress and intention to use technology. The research hypotheses for this study are described as follows:

Hypothesis 1. TPACK and school support have direct effects on secondary school teachers' technostress.

Hypothesis 2. TPACK, school support, and technostress have direct effects on secondary school teachers' intention to use technology.

Hypothesis 3. Technostress has a mediating effect between TPACK, school support, and intention to use technology.

A hypothetical model for this study is illustrated in the following Fig. 1.

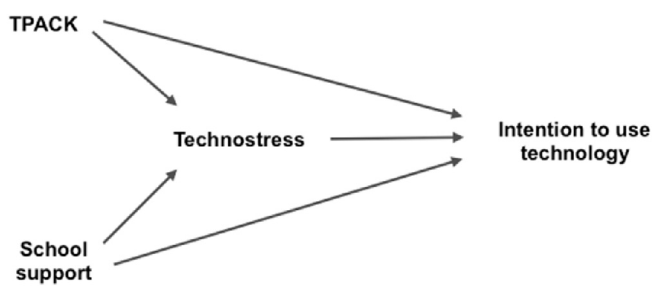


Fig. 1. Hypothesized research model.

3. Method

3.1. Participants

Data were collected from 312 secondary school teachers in South Korea, and they participated in the survey voluntarily. Among these participants, 112 were from middle schools and 200 were from high schools. A total of 61 (19.6%) were in their twenties, 119 (38.1%) in their thirties, 81 (26%) in their forties, and 51 (16.3%) in their fifties. Since convenience sampling method was used for data collection, it was necessary to compare the age distribution of the research sample and the population, that is, the entire secondary school teachers in South Korea. According to the Korean Educational Statistics Service (2015), secondary school teachers in their twenties, thirties, forties, and fifties were respectively 10.6%, 33.1%, 29.9%, and 26.3% in 2014, indicating that younger teachers responded more for the survey. It is probable that teachers in their twenties may have been more interested in the use of technology, which resulted in higher participation rate of the teachers in their twenties for this study. Subjects that the participating teachers taught were Korean (12.5%), English (11.2%), Math (19.9%), Science (19.9%), Social studies (11.9%), art/music/physical exercises (6.1%), second language (3.2%), and others (15.4%).

3.2. Measurement instruments

As illustrated in Table 1, several instruments, which were verified by prior research, were used to provide the study data. The researchers translated all items into Korean, and a university professor in the field of educational technology validated the Korean translation. And then, another three professionals in the field of educational technology reviewed the translated instrument in terms of research context. Lastly, both exploratory and confirmatory factor analysis were conducted to ensure the validity and reliability of the measurement. The instruments used the 5-point Likert scale.

First, in order to measure TPACK, the scale developed by Archambault and Crippen (2009) was adopted, since the original instrument was targeted to K-12 teachers. Sample items are ‘I am able to use technology to create effective representations of content that depart from textbook knowledge’, ‘I am able to use technology to predict students' skill/understanding of a particular topic’. The Cronbach's alpha from the original study was reported as .78, while the present study data had a better alpha value of .87.

Second, school support was measured using the instrument developed by Lam, Cheng, and Choy (2010). Sub-constructs of school support included technical/environmental support and peer support, with a total of 10 items. Technical/environmental support measured the extent to which teachers perceived their schools' supporting structure and appropriate arrangements to facilitate successful technology adoption. A sample item is ‘My school provided sufficient training to us so that I know how to use technology for teaching and learning.’ Peer support measured the extent to which teachers perceived the level of support from their fellow teachers, and a sample item is ‘Many colleagues shared their experience with me regarding the skills in adopting technologies for teaching and learning.’ Cronbach's alphas for technical/environmental support and peer support from the original study were reported as .88 and .91 respectively, and the alphas for the present study were .80 and .86.

Third, technostress was measured using one of the subscales of the Computer Attitude Scale developed by Loyd and Loyd (1985). Unlike other instruments developed for technostress in information management systems, the Computer Attitude Scale was especially designed for teachers. The original instrument consisted of computer anxiety, computer confidence, computer liking, and computer usefulness. Among these subscales, computer anxiety was used to measure the level of technostress, and the items were modified to fit the research context. For example, the terminology for computers in the original instrument was generalized as technology. Example items are ‘I get a sinking feeling when I think of trying to use technology for teaching’, and ‘Technologies make me feel uncomfortable.’ The Cronbach's alpha from the original study was .90, and the alpha for the present study was .89.

Finally, intention to use technology was measured using the 3-item instrument developed by Taylor and Todd (1995). An example item is ‘I intend to use technology for teaching.’ The Cronbach's alpha from the original study was .91, and the alpha for the present study was .94.

3.3. Data collection and analysis

Paper-based surveys on secondary school teachers' TPACK, perception of school support for technology use, technostress, and intention to use technology were distributed in December, 2012 and collected by early January 2013.

The collected data were analyzed according to the procedure for structural equation modeling. First, exploratory factor analysis and confirmatory factor analysis were performed to confirm the validity and reliability of the measurement. Since the results of exploratory factor analysis indicated that TPACK, technostress, and the intention to use technology were unidimensional factors, parcels of items were utilized to minimize overweighting on some variables in the model (Kishton & Widaman, 1994). For each unidimensional factor, items were combined randomly into small groups of items, generating parcels as measurement variables. Each parcel was labeled using a numbering scheme, with the exception of the measurement variables for school support, which included technical/environmental support and peer support. As a result, the

Table 1
Measurement instruments.

Variables	Number of items	Sources	Cronbach's α	Scales
TPACK	4	Archambault and Crippen (2009)	.87	5-point likert scale
School support	10	Lam et al. (2010)	Technical/environmental support: .80 Peer support: .86	
Technostress	10	Loyd and Loyd (1985)	.89	
Intention to use technology	3	Taylor and Todd (1995)	.94	
	Total 27 items			

hypothesized research model was specified as the statistical model with four latent variables and eight measurement variables.

Next, descriptive statistics and correlation analysis were performed using SPSS. Multivariate normality was checked using AMOS. Maximum likelihood estimation was employed as an estimation method, since each variable was normally distributed. In terms of structural equation modeling, the minimum sample discrepancy (CMIN), Tucker–Lewis index (TLI), comparative fit index (CFI), and root-mean-square error of approximation (RMSEA) were used to check the goodness of fit for this study. Item parcels were used for unidimensional factors.

4. Results

4.1. Descriptive statistics and correlations

Descriptive statistics including means, standard deviations, skewness and kurtosis for measurement variables in the research model were analyzed. The means and standard deviations ranged from 2.53 to 3.65, and from .53 to .78, respectively, on a 5-point scale. The maximum for the absolute values of skewness was .61, and that of kurtosis was .51. Since the absolute values for skewness and kurtosis were less than 3 and 10, respectively, the assumption for the multivariate normal distribution of the data were met for structural equation modeling (Kline, 2005). All of the correlation coefficients for the eight measurement variables were statistically significant (Table 2).

4.2. Measurement model

As illustrated in Table 3, the analysis results of maximum likelihood estimation showed that a priori measurement model demonstrated a good fit with the study data (e.g., RMSEA = .055(.023~.086)). That is, the measurement of each latent variable was reliable and valid as well, thus requiring no modifications of the measurement model. So the researchers proceeded to the next step of confirmatory factor analysis (See Table 4 and Fig. 2).

Convergent as well as discriminant validity were checked based on the coefficients among variables. Since coefficients between measurement and latent variables were all above .50, while coefficients between latent variables were all below .80, both the convergent and discriminant validities of the measurement models were adequate, according to the results of confirmatory factor analysis. Therefore, the measurement model did fit the data well.

4.3. Structural model and hypothesis testing

In order to test the structural model, the proposed relationships among the variables were analyzed, and the initial structural model showed a good fit to the study data with TLI of .984, CFI .992, and RMSEA .055 (.023~.086).

Regarding the first research question, the direct effects of TPACK and school support on technostress were examined by reviewing the beta weights. As a result, all of the direct effects were significant as follows: TPACK → technostress: beta = −.534 ($t = -8.571$, $p < .05$), school support → technostress: beta = −.164($t = -2.384$, $p < .05$). For the second research question, the direct effects of TPACK, school support, and technostress on the intention to use technology were examined. The results indicated that technostress had a significant effect on intention to use technology (beta = −.400, $t = -2.384$, $p < .05$). However, TPACK and school support did not have significant effects on intention to use technology.

Hence, the two non-significant paths were removed from the original hypothesized structural model to keep the model concise, and the analysis results showed that the modified model exhibited a good fit, with RMSEA of .054 (.023~.086) as reported in Table 5. Given that the original model and modified model were in a hierarchical relationship, the statistical differences between the two models were tested using χ^2. The results showed that $\Delta\chi^2$ was 3.042 ($p = .219$), indicating no significant difference. Therefore, the modified structural model was confirmed as the final research model. The results of re-examined standardized path coefficients of the modified model are illustrated in Table 6 and Fig. 3.

In order to answer the third research question, the mediating effects of technostress between TPACK, school support, and intention to use technology were examined using the Sobel test method (Sobel, 1982). First, technostress significantly mediated TPACK and intention to use technology ($z = 6.193$, $p < .05$). Second, technostress also significantly mediated school

Table 2
Descriptive statistics and correlation coefficients.

Measurement Variable	1	2	3	4	5	6	7	8
1. TPACK 1	–							
2. TPACK 2	.83*	–						
3. Technical/environmental support	.31*	.28*	–					
4. Peer support	.35*	.35*	.53*	–				
5. Technostress 1	−.55*	−.52*	−.19*	−.38*	–			
6. Technostress 2	−.49*	−.48*	−.19*	−.26*	.85*	–		
7. Intention to use technology 1	.33*	.33*	.14*	.19*	−.44*	−.45*	–	
8. Intention to use technology 2	.32*	.32*	.12*	.19*	−.41*	−.42*	.90*	–
Mean	3.43*	3.37*	2.84*	3.37	2.53*	2.55*	3.65*	3.64*
SD	.70*	.72*	.71*	.69	.67*	.74*	.88*	.95*
Skewness	−.41*	−.24*	.20*	−.34	.61*	.26*	−.53*	−.44*
Kurtosis	.06*	−.04*	−.16*	.07	.51*	−.11*	.19*	−.12*

*$p < .05$.

Table 3
Fit statistics for the measurement model ($n = 312$).

	$CMIN(\chi^2)$	p	df	TLI	CFI	RMSEA (90% confidence interval)
Measurement model	27.41	.02	14	.984	.992	.055 (.023–.086)
Criteria	–		–	>.90	>.90	<.08

Table 4
Coefficients of the measurement model ($n = 312$).

Latent Variable	Measurement variable	Unstandardized coefficient(B)	Standardized coefficient(β)	S.E.	t
TPACK	TPACK 1	1.015	.939	.059	17.136*
	TPACK 2	1.000	.888		
School support	Technical/environmental support	.759	.622	.126	6.000*
	Peer support	1.000	.852		
Technostress	Technostress 1	.969	.960	.050	19.565*
	Technostress 2	1.000	.888		
Intention to use technology	Intention to use technology 1	.976	.971	.055	17.629*
	Intention to use technology 2	1.000	.925		

*$p < .05$.

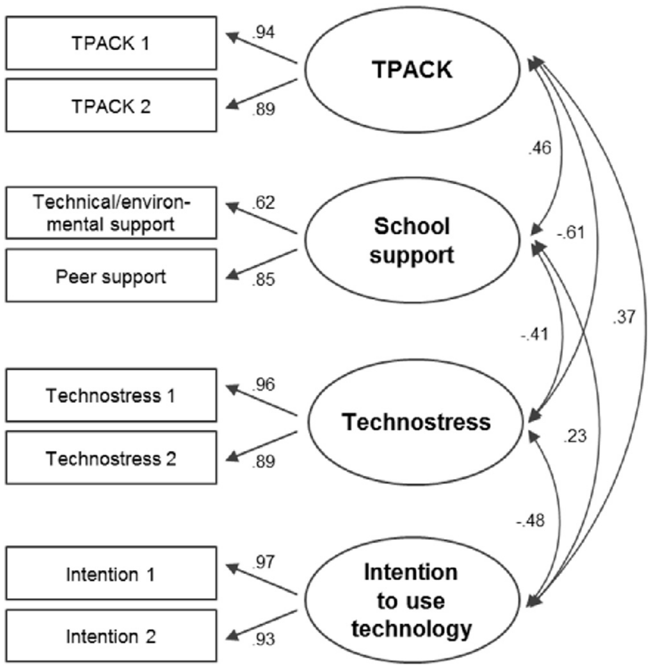


Fig. 2. Convergent and discriminant validity of the measurement model.

Table 5
Fit statistics for the structural models ($n = 312$).

	CMIN(χ^2)	p	df	TLI	CFI	RMSEA (90% confidence interval)
Hypothesized model	27.41	.02	14	.984	.992	.055 (.023–.086)
Modified model	30.45	.02	16	.984	.991	.054 (.023–.086)
Criteria	–		–	>.90	>.90	<.08

Table 6
Coefficients of the modified structural model ($n = 312$).

Variables			Unstandardized coefficient (B)	Standardized coefficient (β)	S.E.	t	p
TPACK	→	Technostress	−.539	−.539	.062	−8.633*	.000
School support	→		−.175	−.160	.075	−2.332*	.020
Technostress	→	Intention to use technology	−.653	−.485	.074	−8.783*	.000

*$p < .05$.

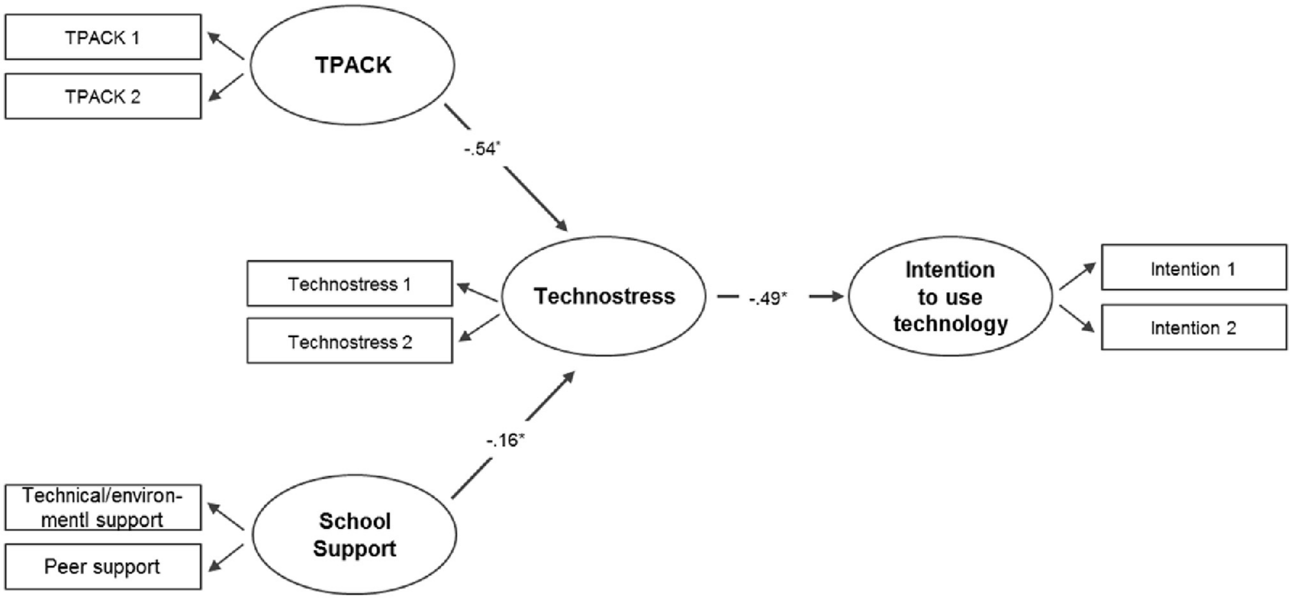
support and intention to use technology ($z = 2.256$, $p < .05$). Specifically, the indirect effect of TPACK on the intention to use technology mediated by technostress was .262, while the indirect effect of school support on the intention to use technology mediated by technostress was .078. The coefficients for direct and indirect effects are decomposed in Table 7.

5. Discussion

This study examined the structural relationships between factors influencing secondary school teachers' technostress and intention to use technology for teaching. TPACK and school support were suggested as critical factors influencing technostress and intention to use technology. The analysis revealed the following: First, TPACK and school support had significant effects on technostress. This means that teachers with the ability to integrate technology and the curriculum cope better with psychological stress regarding technology. This result echoes the results from previous studies such as Kay (2008) and Hardy (1998). Specifically, Hardy (1998) argued, based on theoretical review, that teachers with knowledge and experience in technology use are likely to have lower levels of anxiety with computer integration. Hence, before the nation-wide diffusion of new technology for the SMART initiative, administrators should design professional development programs to promote teachers’ technological and pedagogical knowledge that are useful for technology integration. Also, the result indicating that school support significantly affects technostress implies that not only appropriate technical support but also social support from peers, such as communication with colleague teachers, are necessary to reduce teachers' technostress. In order to facilitate a supporting atmosphere among teachers, strategies such as communities of practice are suggested (Shulman & Shulman, 2004), so teachers can experience emotional support from others and develop their expertise by sharing knowledge.

However, TPACK did not show a significant effect on intention to use technology, which contrasts with the claims that the development of teachers' TPACK would influence their use of technology (Grandgennett, 2008). This indicates that teachers' use of technology may not depend entirely on their current knowledge of content and technology. Also, school support had a non-significant effect on intention to use technology. In South Korea, teachers tend to use technology primarily to meet governmental policies and needs rather than due to their own belief in technological effectiveness (Baek, Jong, & Kim, 2008). When teachers feel pressured to change their pedagogy and to use new technologies due to external requests, they are more likely to resist adopting the technology (Ertmer, 2005). Therefore, administrators and researchers should be aware of the negative side of top-down strategies for technology use, and recognize the technostress that teachers may experience during the adoption process. As technostress was revealed as a significant mediator, teachers' psychological states should be considered important for promoting teachers’ behavioral intention to use technology. In short, the human mind is the key to changes.

Based on the results of this study, further research is suggested as follows: First, two predictors were incorporated in the model used in the present study: TPACK as an individual factor and school support as an environmental factor. However, continued research is needed to investigate other factors such as teaching experience and self-efficacy. Second, it would also be meaningful to analyze teachers' technostress after the adoption of new technology, including both behavioral intention to use and actual use in one research model. Third, one of the limitations of this study is that the subject characteristics were limited to secondary school teachers in South Korea, where the new initiative had just begun. Further investigations with different cultures and contexts are worth trying to enhance our understanding of the phenomenon of technology adoption. Lastly, the sample of the study included relatively more teachers in their twenties compared to the population, which may limit the generalization of the study results. In order to elaborate the research agenda, further studies with teachers of specific age level, or research design with age as a moderating variable may provide another insights for teachers’ use of technology in secondary education.



* $p < .05$

Fig. 3. Modified model with standardized path coefficients.

Table 7
Effect decomposition for the modified model (n = 312).

Variables			Unstandardized coefficient (B)			Standardized coefficient (β)		
			Direct	Indirect	Total	Direct	Indirect	Total
TPACK	→	Technostress	−.539	.000	−.539	−.539	.000	−.539
School support	→		−.175	.000	−.175	−.160	.000	−.160
TPACK	→	Intention to use technology	.000	.352	.352	.000	.262	.262
School support	→		.000	.114	.114	.000	.078	.078
Technostress	→		−.653	.000	−.653	−.485	.000	−.485

Acknowledgments

This work was supported by National Research Foundation of Korea Grant funded by the Korean Government (2012–045331).

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