Asian Journal of Distance Education

Testing the Effects of Technological Barriers on High School Teachers' Role in Technology Integration

Nazire Burcin Hamutoglu

Abstract: The extent of barriers in technology integration that teachers have faced in the teaching-learning process has long been the focus of researchers. The main purpose of the current study is to map the perceived internal and external barriers of teachers on TAM while integrating technology into their classroom. The proposed comprehensive model was extended with the internal and external barriers and analyzed by the structural regression technique. The findings, from a sample of 399 teachers across Turkey, show that internal technology barriers have a direct effect on perceived usefulness, perceived ease of use, attitudes, and behavioural intention. External technology barriers do not have a direct effect but have an indirect effect on perceived usefulness, perceived ease of use, attitudes and behavioural intention. Finally, the findings show that external technology barriers have a direct impact on internal technology barriers.

Keywords: Acceptance, barriers, external, improving classroom teaching, TAM.

Highlights

What is already known about this topic:

- It is already known that barriers and individual acceptance and intention to use are crucial factors for successful and effective technology integration at schools.
- It is already known that perceived ease of use has a significant effect on perceived usefulness, and perceived usefulness has a significant effect on attitude.
- It is also known that attitude is a significant predictor of behavioral intention.

What this paper adds:

- The paper makes use of a well-known statistical method, structural regression, to look at the interaction of two variables of key importance in technology integration; the internal and external barriers and investigates their impact on technology integration.
- Internal technology barriers have a direct effect on perceived benefit, perceived ease of use, attitudes, and behavioural intention of teachers,
- External technology barriers do not have a direct effect but rather an indirect effect on perceived benefit, perceived ease of use, attitudes, and behavioural intention of teachers, and
- External technology barriers have a direct impact on internal technology barriers.

The implications of the presented paper for practice and/or policy are as follows:

- Owing to the finding that, external barriers indirectly impact technology integration, through internal barriers, it is obvious that investment in technological infrastructure in education will not necessarily lead to technology integration,
- To successfully integrate technology into education, the internal barriers must be removed.

Published by EdTechReview (ETR), New Delhi, India
ISSN 1347-9008 http://www.asianjde.org

Introduction

As far as technology integration is concerned, technology barriers seem to be an important element in the literature and are discussed together in many studies (Birisci & Kul, 2019; Ertmer, 2005; Franklin et al., 2001). Considering the aspects explaining the technology barriers in the studies, any factor related to the attitudes and beliefs of individuals refers to an internal barrier while factors such as time, technical and institutional support, infrastructure and so on refer to external barriers to technology integration, and the lack of these factors have been defined as a reason for poor technology implementations. According to Rogers (2003), external barriers are related to usability, technical and institutional support, accessibility to technology, stakeholder development, time and material issues while teachers' beliefs and attitudes about computers and classroom practices and reluctance to change are internal barriers. Undoubtedly, these limitations present barriers to the use of technologies, and more importantly, to their integration into education. Indeed, individuals' self-efficacy skill in learning and teaching activities is important as an internal barrier when using a new technology whereas any situation caused by lack of vision in the institution in which they are working is considered an external barrier. Although many different variables have been studied on the integration of technology into the learning process, Fabry and Higgs (1997) state that not only is the access and presence of a successful integration relevant but also related to how teachers perceive and use technology and point out that internal barriers are as important as external barriers. Based on this inadequacy, Basarmak and Hamutoglu (2020a) examine the concepts discussed in previous studies on technology barriers in fourteen aspects and address them under internal and external barriers within a broad framework and explain how problems experienced by individuals are related to integration as internal variables. Similarly, external barriers are discussed as variables affecting the technology integration independently of an individual. It is possible to argue that variables discussed in the matter of technology barriers play a key role in technology integration.

Theoretical Framework

Theories about the Individual Use and Acceptance of Technology

When it comes to technology integration, there are many theories about the individual use and acceptance of technology. Accordingly, it is observed in the literature that the theories on which integration studies are based are classified as "for adoption and diffusion of innovation", "acceptance of technology", and "models in learning environments" (Çakıroğlu, 2013). Examples of theories on "adoption and diffusion of innovation" include Rogers' (2003) "Diffusion of Innovation Theory" and Fishbein and Ajzen's (1975) "Theory of Reasoned Action" and Taylor and Todd (1995)'s "Theory of Planned Behavior" Caused Behavioral Theory". Given the philosophy taken as a basis by these theories, several psychological variables (i.g. motivation, attitude) which are specific to an individual and his/her social environment is effective with the formation of intention towards innovation in the integration of innovation. Furthermore, Technology Acceptance Model-1 (TAM) (Davis, 1989), TAM-2 (Venkatesh & Davis, 2000), TAM-3 (Venkatesh & Bala, 2008), UTAUT (Venkatesh et al., 2003), Social Cognitive Model (Bandura, 1986), Motivation Model (Davis et al., 1992) and Model of Personal Computer Utilization (Triandis, 1980) addressing the acceptance of technology argue that individual attitudes and beliefs are dominant in technology integration. Finally, as for the technology integration application models in learning environments, Five-Stage Computer Technologies (Toledo, 2005), Systematic Planning Model (Wang & Woo, 2007); Technology, Pedagogy and Content Knowledge (TPACK) (Mishra & Koehler, 2006); Generic Model of Pedagogy, Social Interaction and Technology (Wang, 2008), E-Capacity Model (Vanderlinde & Braak, 2010), Concentric Circles Model (Tondeur et al., 2008), 5Ws and 1H Model (Haslaman et al., 2008), Activity System Model (Demiraslan & Usluel, 2006), Technology Integration Planning Model (Roblyer, 2006) discuss the integration studies at the level of school and teacher. The common ground of all these theories in the literature is the integration of technology into education.

The Constructs of TAM that Influence Technology Integration

Considering the call of incorporating acceptance and individual use of technology into technology integration, this study used TAM to investigate the impact of internal and external barriers on teachers in integrating technology into education. TAM, a well-known theoretical model which addresses the reasons behind of users' acceptance or refusal of technology, is simple to use and easy to understand, and widely used in many empirical studies to address this behaviour. TAM was proposed by Davis (1989) and has become one of the most applied models when explaining and predicting the acceptance of users of a technology (Holden & Karsh, 2010). TAM comprises five core variables with three of them based on user motivation such as perceived ease of use (PEU), perceived usefulness (PU), and attitudes toward technology (ATT). Two other variables, behavioural intentions (BI) and technology use (TU) are considered as outcome variables. Marangunić and Granić (2015) assert that of these variables, PU and PEU are considered main variables which explain the outcome variables (i.e. BI and TU) directly or indirectly.

The conceptualizations of TAM variables explained by Davis (1989) are as follows: While PEU is the degree to which a person believes that using technology would be free of effort, PU is the degree to which a person believes that using technology would enhance his or her job performance. On the other hand, ATT is defined as a specific behaviour which is associated with the use of technology. Finally, while BI is used to explain the users' intention towards the use of technology in the future, TU is used for explaining the actual use by a person. There are several extensions of TAM extended by external factors (e.g. facilitating conditions, subjective norm, self-efficacy, perceived enjoyment, technical support, satisfaction, performance, anxiety, technological complexity, compatibility, motivation, experience) (Sánchez-Prieto et al., 2019; Scherer et al., 2019; Taherdoost, 2018; Yang & Wang, 2019). Although TAM is the most commonly dominated model used to describe intentions and actual technology use (Marangunić & Granić, 2015), it falls short of conceptualizing what it means to accept and integrate technology in classrooms in a wide research landscape (Scherer et al., 2019). Therefore, integration of technology requires a multidimensional approach that goes beyond strengthening teachers' abilities and beliefs of competence (Straub, 2009).

The Influencing of both Barriers and Acceptance of Technology in Technology Integration

As can be seen, theories/models in the literature discuss different variables in technology adaptation. Also, it is possible to say that almost all of these variables are related to internal and external factors. For example, attitudes, intention, perceived usefulness, and perceived ease of use addressed by Davis (1989) in TAM refer to internal factors. Similarly, subjective norm, image, social impact and facilitating conditions addressed by Venkatesh and Davis (2000) in TAM-2, Venkatesh and Bala (2008) in TAM-3 and Venkatesh et al. (2003) in UTAUT model refer to external factors. It is noted that these variables, which are described as internal and external factors, are subject to studies on technology integration (Paciga et al., 2019). In addition to this, while Purnomo and Kustandar (2019) discovered that individual barriers, cultural barriers, government policy barriers, support and technological barriers significantly influenced the acceptance of ICT, Sánchez-Prieto et al. (2019) pointed out that second-order barriers (or internal barriers) are important predictors of the behavioral intention. Finally, recent studies emphasize the importance of attitudes and beliefs, crucial factors for technology integration, in teachers planning and implementing technology into the classroom settings (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010; Purnomo & Kustandar, 2019; Sánchez-Prieto et al., 2019).

Purpose and significance of the study

In light of the studies in the literature, it suggests that both barriers and acceptance are very important in the integration of technology into educational environments. This study purposes to map the perceived internal and external barriers of teachers on TAM while integrating technology into the classroom. In the previous sections, the external variables which are the extensions of TAM were presented. Among the

studies, the extended versions of TAM that explained several external factors are not enough to explain technology integration. Considering that the integration of educational technologies into the classroom settings is an issue that concerns educators it is suggested that this topic needs to be investigated based on pedagogical strategies. This study aimed to provide a comprehensive overview and deeper understanding of technology integration within the context of TAM by extending two crucial factors: internal and external barriers in technology integration. This current study examines the core question: "How do internal and external barriers to technology integration affect individual use and acceptance?" In this context, answers were sought to the following sub-questions:

1. What is the effect of internal and external barriers to technology integration on perceived usefulness?
2. What is the effect of internal and external barriers to technology integration on perceived ease of use?
3. What is the effect of internal and external barriers to technology integration on attitude?
4. What is the effect of internal and external barriers to technology integration on behavioural intention?

Method

This study aimed to test the effects of internal and external barriers of teachers perceived on the technology acceptance model (TAM) in technology integration with the structural regression model. To do this, the research was conducted based on a convenience sampling method following the relational survey model, a quantitative research method. According to Karasar (2008), these models measure the degree and presence of the change among variables. The tested model with structural regression is provided.

Participants

The participants of the study were teachers who worked at public high schools in all content areas during the 2018-2019 academic year in an Anatolian city centre of Turkey. The participants comprised 59.1% (f=236) male and 40.9% (f=163) female, and 399 participated in the research voluntarily (sd=0.49; M=1.59). The age of participants ranged from 23 to 62 (sd=7.32; M=41.49), and their years in the professions were between 1 and 38 years (sd=7.82; M=17.94).

Instruments

Perceived Barriers to Technology Integration (PBTI) Scale

The developed scale called Perceived Barriers to Technology Integration (PBTI) (Basarmak & Hamutoglu, 2020a) is comprised of 51 items and has a construct of 14 factors: beliefs towards learning-teaching activities-BLTA, beliefs towards the expert support-BES, technological self-efficacy beliefs-TSEB, pedagogical self-efficacy beliefs-PSEB, beliefs towards change-BC, lack of vision-LV, lack of leadership-LL, lack of money-LM, family resistance-FR, lack of training-LT, infrastructure-INF, content-CONT, time-TIME, assessment-ASSES. It was determined that the scale had construct validity and reliability (Basarmak & Hamutoglu, 2020a). Higher scores in the scale refer to a higher perceived barrier to technology integration.

Technology Acceptance Scale

The Technology Acceptance Scale developed by Ursavaş et al. (2014) and four sub-factors of developed scale perceived usefulness (PU), perceived ease of use (PEU), attitude towards use (ATTD), and intention (INT) were used to measure teachers' technology acceptance. Accordingly, the developed scale showed a reliable and valid structure (Ursavaş et al., 2014).

Data Analysis

In the analysis, while the procedures for the structural regression model were performed with AMOS software package program, SPSS was used to achieve descriptive statistics. The Microsoft Excel software package was used to calculate the effect size. A structural regression analysis, which is a structural equation model, was used to investigate the effects of the variables that were thought to be theoretically interrelated in the study. The structural regression analysis processes used to handle the observed variables (Raykov & Marcoulides, 2006) is a method used to examine causation among two or more variables. Effect size values for each structural equation were also calculated.

Findings

The structural regression analysis was used to test the model developed in the study. The relationship among internal barriers, external barriers, perceived usefulness, perceived ease of use, attitude, and intention were examined and among them, direct and indirect effects of internal and external barriers were identified in this analysis. Table 1 summarizes the mean, standard deviation, and correlation values and Table 2 summarizes the fit values achieved regarding the path analysis.

Table 1: Mean, Standard Deviation and Correlation Values of Data

	N	*Min.*	*Max*	*M*	*SD*	*Skewness*	*Kurtosis*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
INTERNAL (1)	399	30	95	62.51	11.45	-0.014	0.042	1					
EXTERNAL (2)	399	17	58	38.98	7.75	-0.101	0.16	0.475**	1				
PU (3)	399	12.0	2500	20.60	2.68	-0.129	0,.39	-0.559**	-0.439**	1			
PEU (4)	399	7	15	12.14	1.67	-0,.56	0.433	-0.442**	-0.469**	0.515**	1		
ATTD (5)	399	10	20	16.79	2.09	-0.008	0.208	-0.533**	-0.401**	0.702**	0.608**	1	
INT (6)	399	9	20	16.46	2.22	-0.178	0.585	-0.559**	-0.461**	0.628**	0.598**	0.760**	1

INTERNAL: Internal barriers; EXTERNAL: External barriers; PU: Perceived usefulness; PEU: Perceived ease of use; ATTD: Attitude; INT: Intention 0.05>p; 0.01>p***

In Table 1 the relationship among the research variables was significant and at the expected level. These results indicate that there were important and significant effects among the variables. Regarding the fit indexes in in the structural regression model, the model seems to have perfect and acceptable fit indexes (χ^2/sd =336.395/92) =3.65; CFI=0.90; IFI=0.90; GFI=0.90; AGFI=0.86; RMSEA=0.08; SRMR=0.06) (Bentler & Bonett, 1980; Browne & Cudeck, 1993; Jöreskog & Sorbom, 1993).

As shown in Figure 1, the model developed and tested with the structural regression technique, can be best discussed when considered together with Tables 2 & 3. A model for understanding the impact of internal and external factors in technology integration is first proposed. Then, through the use of a measurement tool, the effects of these factors have been identified. The TAM factors (INT, ATTD, PU, and PEU) become dependent factors when they are affected by another factor (i.e. when they are at the receiving end of an arrow). The weight factors show the impact of a factor on the receiving one. Hence, the model explains the role of internal and external factors already discussed above.

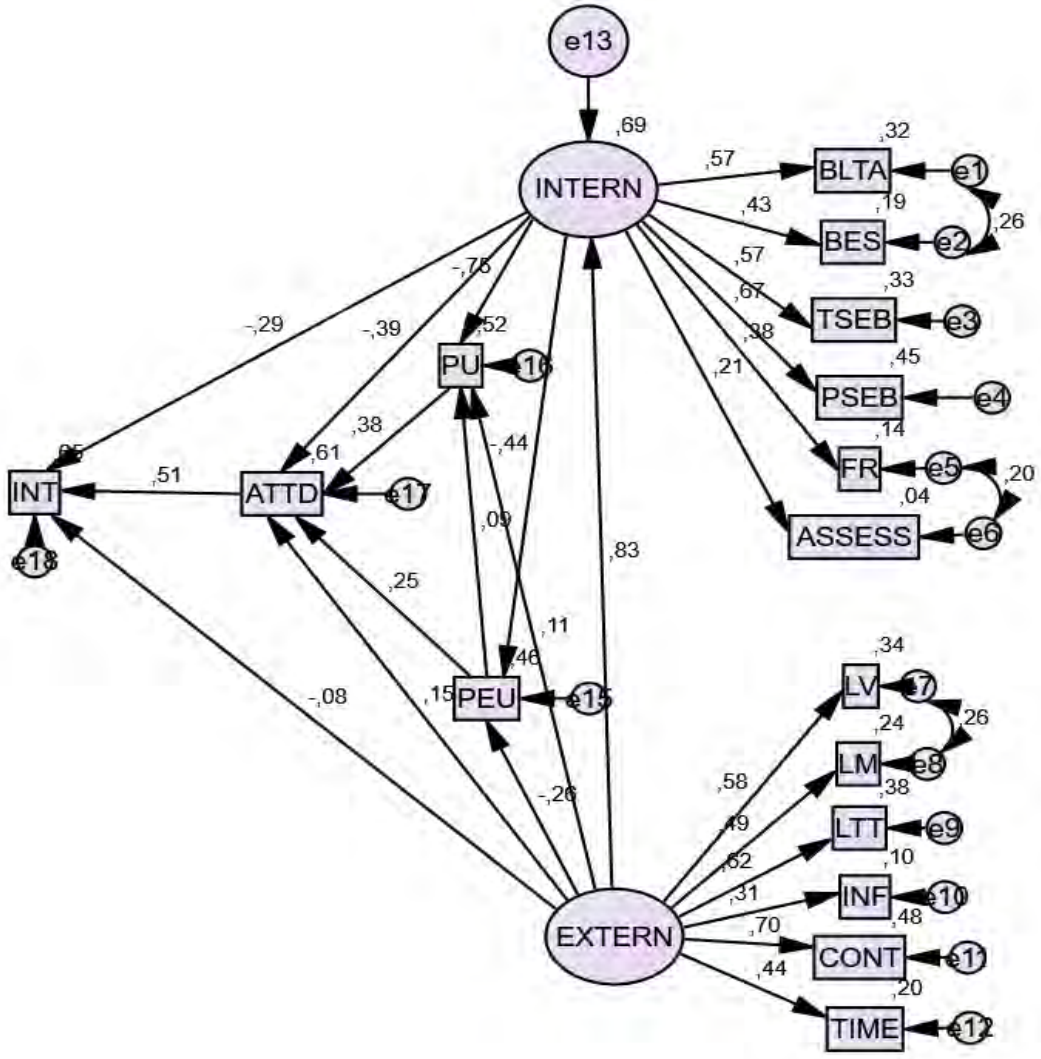

Figure 1: Testing the Technological Barriers to Technology Integration: Structural Regression Model

Table 2: The Effects of INTERNAL Factors on Dependent Variables

Dependent Variable	Independent Variable	Total Effect	Direct Effect	Indirect Effect	SE	Critical Ratio (t)
PEU	INTERNAL	-0.443	-0.443	-	0.162	-3,144**
PU	INTERNAL	-0.792	-0.753	-0.039	0.330	-4,201***
ATTD	INTERNAL	-0.798	-0.388	-0.410	0.235	-2,372*
INT	INTERNAL	-0.699	-0.295	-0.404	0.194	-2,320*
ASSES	INTERNAL	0.205	0.205	-	0.099	3,646***
FR	INTERNAL	0.376	0.376	-	0.141	6,322***
PSEB	INTERNAL	0.673	0.673	-	0.111	9,763***
TSEB	INTERNAL	0.574	0.574	-	0.135	8,791***
BES	INTERNAL	0.431	0.431	-	0.176	8.160***
BLTA	INTERNAL	0.566	0.566	-	-	-

0.05>p; 0.01>p**; 0.001>p*** (BLTA- beliefs towards learning-teaching activities, BES- beliefs towards the expert support, TSEB- technological self-efficacy beliefs, PSEB- pedagogical self-efficacy beliefs, LV-lack of vision, LM- lack of money, FR- family resistance, LT- lack of training, INF- infrastructure, CONT-content, TIME-time, ASSES- assessment, PU- perceived usefulness, PEU- perceived ease of use, ATTD- attitude, INT- intention)*

As seen in Figure 1 and Table 2, the independent variable of INTERNAL barrier was affected directly and positively by the dependent variables of ASSES (β=0.21, p<0.001), FR (β=0.38, p<0.001), PSEB (β=0.67, p<0.001), TSEB (β=0.57, p<0.001), BES (β=0.43, p<0.001), and BLTA (β=0.57, p<0.001), and negatively affected by PEU (β=0.44, p<0.001), PU (β=0.75, p<0.001), ATTD (β=0.39, p<0.05), INT (β=0.29, p<0.05).

Table 3: The Effects of EXTERNAL Factors on Dependent Variables

Dependent Variable	Independent Variable	Total Effect	Direct Effect	Indirect Effect	SE	Critical Ratio (t)
BLTA	EXTERNAL	0.469	-	0.469	-	-
BES	EXTERNAL	0.357	-	0.357	-	-
TSEB	EXTERNAL	0.475	-	0.475	-	-
PSEB	EXTERNAL	0.558	-	0.558	-	-
FR	EXTERNAL	0.311	-	0.311	-	-
ASSES	EXTERNAL	0.170	-	0.170	-	-
LV	EXTERNAL	0.579	0.579	-	-	-
LM	EXTERNAL	0.491	0.491	-	0.066	8,942***
LTT	EXTERNAL	0.617	0.617	-	0.088	9,019***
INF	EXTERNAL	0.313	0.313	-	0.183	5.269***
CONT	EXTERNAL	0.696	0.696	-	0.103	9.685***
TIME	EXTERNAL	0.444	0.444	-	0.109	7.094***
INTERNAL	EXTERNAL	0.83	0.829	-	0.132	7.767***
PEU	EXTERNAL	-0.631	-0.264	-0.367	0.193	-1.934
PU	EXTERNAL	-0.567	0.112	-0.679	0.350	0.730
ATTD	EXTERNAL	-0.546	0.146	-0.693	0.217	1.203
INT	EXTERNAL	-0.606	-0.085	-0.521	0.193	-0.830
PU	PEU	0.088	0.088	-	0.107	1.319
ATTD	PEU	0.282	0.249	0.033	0.064	4.854***
INT	PEU	0.143	-	0.143	-	-
ATTD	PU	0.378	0.378	-	0.051	5.765***
INT	PU	0.192	-	0.192	-	-
INT	ATTID	0.507	0.507	-	0.059	9.178***

0.05>p; 0.01>p**; 0.001>p*** (BLTA- beliefs towards learning-teaching activities, BES- beliefs towards the expert support, TSEB- technological self-efficacy beliefs, PSEB- pedagogical self-efficacy beliefs, LV-lack of vision, LM- lack of money, FR- family resistance, LT- lack of training, INF- infrastructure, CONT-content, TIME-time, ASSES- assessment, PU- perceived usefulness, PEU- perceived ease of use, ATTD- attitude, INT- intention)*

Also, as seen in Figure 1 and Table 3, the independent variable of EXTERNAL barrier was affected directly and positively by the dependent variables of LM (β=0.49, p<0.001), LTT (β=0.62, p<0.001), INF (β=0.31, p<0.01), CONT (β=0.70, p<0.001), TIME (β=0.44, p<0.001), and LV (β=0.58, p<0.001). The independent variable of EXTERNAL was affected indirectly and positively by the dependent variables of BLTA (β=0.47, p<0.001), BES (β=0.36, p<0.001), TSEB (β=0.47, p<0.001), FR (β=0.31, p<0.001), ASSES (β=0.17, p<0.001), and PSEB (β=0.56, p<0.001). It was also observed that the independent variable of EXTERNAL had a direct and positive effect on the INTERNAL variable (β=0.83, p<0.001).

In the model, the INTERNAL variable was explained by the EXTERNAL variable at 69% (r^2=0.69). In addition to this, PU was explained by INTERNAL at 52% (r^2=0.52); PEU was explained by INTERNAL at 46% (r^2=0.46); ATTD was explained by INTERNAL, PEU, PU at 61% (r^2=0.61) and INT was explained by INTERNAL and ATTD at 65% (r^2=0.65).

From these findings given above, the following can be deduced:

1. As an important predictor of the internal barriers, the external barriers explain 69% of the total variance. This implies that reducing the effects of internal barriers (e.g. beliefs concerning teaching and learning activities, beliefs in technological self-sufficiency etc.), depends on the removal or minimization of external barriers (e.g. infrastructure, time, context etc.) at a high rate of 69%.
2. The important variables in technology integration; PU and PEU are explained by internal barriers at a rate of %46 and %52 respectively. In other words, improvement of PU depends on the removal or

minimization of internal barriers (52%) and removal or minimization of external barriers alone will not suffice. While the internal barriers are present, solving problems such as infrastructure will not improve PU in technology integration. The internal barriers play a moderator role between PU and external barriers.

3. Similarly, another important factor in technology integration, the PEU will not be directly impacted by the removal or minimization of external barriers. It is essential that internal variables such as specialist support, the belief of technological self-sufficiency etc. are also provided.
4. Due to the impact of PU and PEU on ATTD, to improve this variable, removal or minimization of internal barriers is more important than the removal or minimization of external barriers.
5. Finally, an important predictor in technology acceptance, INT is strongly affected by ATTD and internal factors. Hence, to positively change the attitude in technology integration the removal or minimization of internal factors or a change in ATTD is important.

Finally, in the model, the calculated effects on PU, PEU, ATTD, INT (f^2) were 1.08, 0.85, 1.56, and 1.86, respectively. According to the (f^2) values, it can be said that the dependent variables INTERNAL, PU, PEU, ATTD and INT showed that the effect sizes of the equations were large (Cohen, 1988). As can be seen from the effect size results, the findings presented in this work have all been confirmed. The impact of the work is likely to cover a wide area and it can be generalised.

Discussion

The effects of internal barriers to technology on perceived usefulness

In this study, it was found that internal barriers had a negative and direct significant effect on perceived usefulness. The individual's perception of usefulness is defined by Davis as the "degree to which a person's use of a particular system will improve their performance" (Davis, 1989, p. 320). Teachers' self-efficacy beliefs toward learning-teaching activities are thought to be in relation to the degree to which the individual believes that she/he will improve performance. Similarly, individual beliefs towards expert support will affect perceived usefulness because it is considered that receiving expert support in the integration of new technology into the learning process is important for individuals. The individuals who receive expert support will have an advantage over others in using technology effectively. As an internal barrier, the teachers' perceived self-efficacy impacts on teachers' perception of usefulness. It is possible to say that this is important in technology integration in education. The effect of perceived self-efficacy on usefulness is important in technology integration (Igbaria & Ilvari, 1995). The authors emphasize that "self-efficacy was proposed to be an antecedent of perceived ease of use and usefulness that had mainly indirect effects on usage through the ease of use and perceived usefulness" (p.593). TAM 3 (Venkatesh & Bala, 2008) shows that computer self-efficacy has a direct effect on perceived ease of use and so does the ease of use on perceived usefulness. The effect of perceived self-efficacy on usefulness found confirms findings previously reported (Igbaria & Ilvari, 1995; Venkatesh & Bala, 2008) highlighting that the adaptation of technology to learning processes requires both technological and pedagogical competence. This leads to the fact that teachers dispose of internal barriers when improving their knowledge and skills in technology-aided learning environments and increasing the score of perceived usefulness.

Family resistance, which is the last factor discussed within internal barriers, is thought to have a negative effect on perceived usefulness in technology integration based on past experiences. Depending on teachers' past experiences, their family's negative technological attitude may overshadow the fact that individuals will regard technology as a useful instrument in learning environments in the future. It is anticipated that negative opinions of technology in teachers' families may cause negative reflections on perceived usefulness in technology integration. This could be the reason why negative effects of barriers regarding teachers' learning processes, expert support, technological and pedagogical self-efficacy, assessment and family resistance on perceived usefulness are recognized as issues to be considered

in technology integration. Indeed, there are studies in the literature indicating that technological self-efficacy affects technology acceptance (Lai, 2008; Scherer et al., 2019).

The effects of internal barriers to technology on ease of use

This study suggests that internal barriers had a direct and negative significant effect on ease of use. Perceived ease of use was described as the "degree to which a person believes that using a particular system will not require an effort" (Davis, 1989, p. 320) and considered an indicator of perceived usefulness and attitude towards use (Davis, 1989). Accordingly, it is possible to say that the dimensions described as internal barriers affected the ease of use perceived by the teachers. No matter how easy the technology used is for a teacher, without a self-efficacy belief toward learning and teaching activities using technology, a teacher's belief may adversely affect the process of technology integration. Similarly, the findings of this work indicate that, providing expert support to teachers will not present a barrier in technology integration and will shape teachers' perceived ease of use of technology. Similar findings are reported by other authors too: "Based on existing literature, trust, ICT anxiety and perceived ease of use are identified as factors that may influence industry experts to provide structural empowerment." (Abdullah & Kian, 2019).

Although it is easy to use technology in the presence of an internal barrier experienced by a teacher who lacks pedagogical and technological self-efficacy, it is believed that the lack of pedagogical and technological self-efficacy has a negative effect on their perception. Consider a teacher who lacks the knowledge and skills of using technology and/or has concerns in using technology in education and chooses a technology without considering the characteristics of the target group and/or teaching methods appropriate for the course objectives, the subjects, and attainments when using technology in courses. One can say that the barrier to technology integration due to the lack of technological knowledge and skills and a teacher's pedagogical incompetence may affect perceived ease of use. This can also be explained by the internal barriers of family resistance and assessment in which 'technology is regarded as an unnecessary tool' in teachers' families and 'family resists using technology' is effective in technology integration as well as being important in ease of use.

The effects of internal barriers to technology on attitude

As the results of the study indicated, internal barriers had a negative and direct significant effect on attitude to technology integration. Accordingly, it is thought that self-efficacy perception towards learning-learning activities, which are handled under internal technology barriers, is an effective psychological factor behind the behaviour in technology integration and individual technology acceptance. Similarly, it is possible to argue that belief towards expert support will help teachers develop a positive attitude towards the effective use of technology in the classroom. Fishbein and Ajzen (1975) emphasize in their model that there is a relationship between beliefs and attitudes and that beliefs and attitudes are important in the adoption of technology. This suggests that the beliefs towards expert support in technology integration will nourish attitudes. A similar case is observed in pedagogical and technological self-efficacy beliefs. Teachers' self-efficacy beliefs in using technology in the classroom and their pedagogical approaches are thought to be effective in their attitudes. It is not possible for teachers who feel nervous, anxious, and concerned when using the technology during learning processes to perform a successful technology integration as their attitudes towards technology will be adversely affected. It can be stated that this is related to families' and/or friends' attitudes towards technology in the past experiences of individuals. Finally, one can say that, as understood from the considerations related to the assessment factor of internal technology barriers, the fact that technology functions as a tool for the evaluation of learning rather than as a service that serves the teaching-learning activities will have a negative impact on teachers' attitudes. Unfortunately, the concern is that the negative impact on the attitudes due to internal barriers does not serve a successful technology integration and will have negative implications on individual acceptance and use.

The effects of internal barriers to technology integration on individuals' behavioural intentions

The results obtained in the research question which tested the effect of internal technology barriers on behavioural intention indicated a direct and negative significant effect. This finding is parallel to the study of Purnomo and Kustandar (2019) and Sánchez-Prieto et al. (2019). Actually, Purnomo and Kustandar (2019) investigated the barriers to the diffusion of ICT in agricultural extension. They discovered that barriers which stem from technology, individual, etc.) significantly influenced the acceptance of ICT. Moreover, in the study of Sánchez-Prieto et al. (2019), it is pointed out that internal barriers are significantly predict the behavioral intention. Ajzen and Fishbein (1980) describe the behavioural intention as a 'measure of the likelihood that a person can complete a given behaviour' and suggest that motivational factors affect behavioural intention. Accordingly, it is possible to argue that the internal barriers perceived in technology integration affect the individual in a motivational way. We can say that the barriers which a person encounters when fulfilling an objective are impact motivation. Davis et al. (1992) focus on the variables of internal and external motivation in the Motivation Model. These variables are presumably related to the internal barriers that teachers perceive in technology integration. The internalization of such variables that would undermine teachers' motivations due to several barriers may create a negative situation in the future. Indeed, these negative situations stem from internal barriers may lead to adversities in terms of providing a successful technology integration. Because behavioural intention brings along the actual use (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003). Successful integration of teachers' learning processes by supporting them with technology is related to the intention of integrating that technology in the future behaviourally. Similarly, it can be said that the pedagogical and technological beliefs on self-efficacy as internal barriers also nurture the teachers' intention to use technology in the future because it is not possible for a teacher who feels pedagogically and technically inadequate to use technology in the classroom. It is thought that the teacher cannot have the intention to use the technology behaviourally as the barrier experienced by the teacher can create a motivational and psychological gap between the technology and the behaviour. Consequently, it is believed that teachers' perceptions of assessment and their families' attitudes towards technology may have an effect on the quest of integration within the classroom. Here, the impact of internal barriers and ATTD on INT and the implications of these must be recalled.

Indirect effect of external technology barriers on perceived usefulness, perceived ease of use, attitudes and behavioural intention

The study explored that external barriers to technology integration had an indirect effect on perceived usefulness, perceived ease of use, attitude and behavioural intention. It can be argued that external barriers had no direct effect but served the acceptance of technology through internal barriers to technology integration. It is possible to say that this result is quite significant. When it comes to the educational institutions serving a successful technology integration, it is highlighted that shortcomings regarding infrastructure, time, technology-compatible content, vision, education, etc. should be eliminated first. Although this result could be seen to the contrary of Sánchez-Prieto et al. (2019) study, in which second-order barriers are considered as perceived enjoyment, compatibility, and subjective norm. Reporting in their highlights that second-order barriers –which is used in the literature instead of external variables as well– have directly affect TAM, is not related to the external factors discussed in this study. As the results of this study indicated, external barriers alone do not create successful technology integration and technology acceptance. As stated in the study of Chouki et al. (2020) the information and system departments must not think only about the internal barriers of an IT adoption, but both the internal and external barriers to IT adoption. Internal barriers to technology must be emphasized in the integration of technology into learning-teaching processes and in individual acceptance and use. Yang and Wang (2019) showed in their studies that motivation which is an internal factor has an indirect effect on behavioural intention via experience and perceived usefulness. A person who is internally motivated could get over the barriers by gaining experience and may have an intention to use technology into the classroom. Hamutoglu and Basarmak (2020b) show that external barriers to technology is a significant predictor of internal barriers to technology. Metaphorically one can compare

external barriers to the 'shopfront of a store that encourages shopping' and internal barriers to 'customer's budget and standard for the products in the store.' No matter how good the store's shopfront is, the shopping will not take place if the products in the store do not comply with the customer's budget and demand for quality. Because external barriers have no direct effect on the individual acceptance and use of technology but have an indirect effect through internal barriers, the attempts of the institutions to eliminate the external barriers alone will not bring about the adoption of technology.

Implications for practice and/or policy

Based on the findings achieved by structural regression modelling, the importance of the indirect effect of external barriers on individual use and acceptance of technology were identified. The practical implications of the results those who develop and implement educational policies, educators, administrators, teachers, students, experts, pre-service teachers and academics indicate that it is not enough to be investing only in infrastructure and minimizing external barriers for integrating technology to occur. Based on the results, the school administrator might remove the perceived barriers by improving educators and teachers' self-efficacy competencies, attitudes, and beliefs and could help teachers gain experience which is an important and limiting factor in technology integration (Farjon et al., 2019). Technology acceptance and barriers to technology, which are crucial in technology integration, should be considered and supported with pedagogical approaches based on minimizing internal barriers by improving teachers' beliefs, attitudes, self-efficacies etc. In light of the developments in technology, it is obvious that enriching the educational environments with technology also necessitates an integration. It is thought that different variables discussed in this study support the concept of a technology integration that involves several dynamics and will contribute to the literature.

Conclusion

This study aimed to investigate the effects of perceived internal and external barriers to technology acceptance in technology integration. The effects of internal and external barriers, which are thought to affect the variables of perceived usefulness, perceived ease of use, and attitude and behavioural intention were examined separately. The results showed that internal barriers had a direct and significant negative effect on perceived usefulness, perceived ease of use, and attitude and behavioural intention while external barriers did not have any direct effect. This finding is supported in the study of Farjon et al. (2019), stating that attitudes and beliefs could be linked with internal factors and were found to provide the strongest influence in accessing technology. The study showed that internal barriers have a direct and significant effect on individual use and acceptance of technology within the framework of technology integration. Perhaps the most significant finding of the study is that although the external factors were the weakest factors impacting technology integration directly, they seemed to have a direct and significant positive effect on internal barriers. Hence, external barriers only indirectly influence technology integration in education. Empirically, institutional support and perceptions of teachers about their ability to use and integrate technology in the classrooms are important factors. It should be noted as an added value that school administrators, policymakers, educators etc. should avoid investing only in infrastructure, and work on minimizing the impact of external barriers to integrating educational technologies into classroom settings and curriculums. Nelson et al. (2019) supported this conceptual separation in their studies on technology integration barriers. The latest or most expensive technology is not necessarily the one to enhance teaching and learning better. The technologies culturally accepted (unless the culture can be changed) and the ones that people can use with enthusiasm seem to give better results. Institutional policies should be formed after identifying what is acceptable to the users and what can be supported effectively (e.g. through proper training) to improve teachers' acceptance and perceived usefulness. Sometimes a piece of free software such as Moodle can outperform its expensive rivals in being accepted and perceived usefulness. So, internal barriers can be removed through teacher-management interaction.

Limitations to the Study and Recommendations

There are certain limitations to this study which is thought to be contributing to the literature with its findings. This study obtained its data from teachers. In this respect, it can be argued that performing such a study on different target groups may lead to different results. The target group is important in the results achieved. The fact that the location where the data were collected is less populated than other cities presents concern about the study's generalizability. Although the sample is of a good size (*f*=399) and power (*f*2 were calculated for INTERNAL, PU, PEU, ATTD, INT 1.08, 0.85, 1.56, and 1.86, respectively) show a large effect size based on the modelling competent, the study relies solely on self-report data. Future studies could include some objective outcomes (i.e. academic performance) to obtain a stronger design. In addition to this, the results of this study should also be taking into consideration by policymakers and practitioners. Accordingly, it can be said that investing only in infrastructure does not provide effective technology integration by reducing external barriers, and interventions that reduce only internal barriers will be lacking in technology integration. This situation is just like a holistic digital transformation. Just as in digital transformation, the concepts of digitization of information and digitalization come to work; in the relationship between technology integration and technology adoption, the internal and external technology barriers need to be addressed as a whole by policymakers and practitioners. Finally, the study was conducted on the teachers working in public schools. It is anticipated that future studies to be conducted in private and institutional colleges may conclude different perceptions of internal and external barriers to technology integration.

Acknowledgements

Statements on open data and ethics

The present research was carried out considering the ethical guidelines. The participants informed about the privacy of the study and ensured their names were not taken. They participated to the study voluntarily.

Competing interests

The author declares there is no competing interests.

References

Abdullah, A. H., & Kian, N. T. (2019). Modeling factors for industry experts' intention to participate in online scaffolding. *International Journal of Engineering & Technology, 8(*1.8), 73-76.

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behaviour*. Prentice Hall.

Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs.

Basarmak, U., & Hamutoglu, N. B. (2020a). Developing and Validating a Comprehensive Scale to Measure Perceived Barriers to Technology Integration. *International Journal of Technology in Education and Science, 4(*1), 53-71.

Bentler, P. M., & Bonett, D.G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88*, 588-606. https://doi.org/10.1037/0033-2909.88.3.588

Birisci, S., & Kul, E. (2019). Predictors of Technology Integration Self-Efficacy Beliefs of Preservice Teachers. *Contemporary Educational Technology*, *10*(1), 75-93.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In: Bollen, K.A., & Long, J.S. (Eds.), *Testing structural Equation Models* (pp. 136-162). Sage.

Chouki, M., Talea, M., Okar, C., & Chroqui, R. (2020). Barriers to information technology adoption within small and medium enterprises: A systematic literature review. *International Journal of Innovation and Technology Management, 17(*01), 2050007.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Lawrence Erlbaum Associates.

Çakıroğlu, Ü. (2013). Öğretim teknolojilerinin öğrenme ortamlarına entegrasyonu [Integration of instructional technologies into learning environments]. In K. Çağıltay & Y. Göktaş, Y. (Eds.), *Öğretim teknolojilerinin temelleri: teoriler, araştırmalar, eğilimler* [Fundamentals of instructional technologies: theories, researches, trends] (pp. 413-430). Pegem Akademi

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly. 13*(3), 319-340. https://doi.org/10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology, 22(*14), 1111-1132. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x

Demiraslan, Y., & Usluel, Y. (2006). Analyzing the integration of information and communication technologies into teaching-learning process according to activity theory. *Eurasian Journal of Educational Research,* 23, 38-49.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? E*ducational Technology Research and Development, 53*(4), 25–39.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423-435. https://doi.org/10.1016/j.compedu.2012.02.001

Fabry, D.L., & Higgs, J.R. (1997). Barriers to the effective use of technology in education: Current status. *Journal of Educational Computing Research, 17*, 385-395. https://doi.org/10.2190/C770-AWA1-CMQR-YTYV

Farjon, D., Smits, A., & Voogt, J. (2019). Technology integration of pre-service teachers explained by attitudes and beliefs, competency, access, and experience. *Computers & Education, 130*, 81-93. https://doi.org/10.1016/j.compedu.2018.11.010

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: an introduction to theory and research*. Addison-Wesley, Reading MA.

Franklin, T., Turner, S., Kariuki, M., & Duran, M. (2001). Mentoring overcomes barriers to technology integration. *Journal of Computing in Teacher Education, 18(*1), 26-31. https://doi.org/10.1080/10402454.2001.10784428

Hamutoglu, N. B., & Basarmak, U. (2020). External and Internal Barriers in Technology Integration: A Structural Regression Analysis. *Journal of Information Technology Education*, 19, 17-40. https://doi.org/10.28945/4497

Haslaman, T., Kuskaya-Mumcu, F., & Kocak-Usluel, Y. (2008, June). *Integration of ICT into the teaching-learning process: toward a unified model*. In EdMedia: World Conference on Educational Media and Technology (pp. 2384-2389). Association for the Advancement of Computing in Education (AACE).

Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: its past and its future in health care. *Journal of Biomedical Informatics*, *43*(1), 159-172. https://doi.org/10.1016/j.jbi.2009.07.002.

Igbaria, M., & Iivari, J. (1995). The effects of self-efficacy on computer usage. *Omega, 23(*6), 587-605.

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development, 58*(2), 137-154. https://doi.org/10.1007/s11423-009-9132-y.

Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language*. Scientific Software International.

Karasar, N. (2008). *Bilimsel araştırma yöntemi: kavramlar, ilkeler, teknikler* [Scientific research method: concepts, principles, techniques] (Onsekizinci baskı). Nobel Yayın Dağıtım.

Lai, M. L. (2008). Technology readiness, Internet self-efficacy and computing experience of professional accounting students. *Campus-Wide Information Systems, 25(*1), 18-29.

Marangunić, N., & Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in The Information Society, 14(*1), 81-95. https://doi.org/10.1007/s10209-014-0348-1

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108(*6), 1017.

Nelson, M. J., Voithofer, R., & Cheng, S. L. (2019). Mediating factors that influence the technology integration practices of teacher educators. *Computers & Education*, *128*, 330-344. https://doi.org/10.1016/j.compedu.2018.09.023

Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education, 55*(3), 1321-1335. https://doi.org/10.1016/j.compedu.2010.06.002

Paciga, K. A., Fowler, A., & Quest, M. (2019). Constructing preservice teachers' knowledge of technology integration. in *Advanced methodologies and technologies in modern education delivery* (pp. 879-892). IGI Global. https://doi.org/10.4018/978-1-5225-7365-4.ch068

Purnomo, S. H., & Kusnandar. (2019). Barriers to acceptance of information and communication technology in agricultural extension in Indonesia. *Information Development, 35(*4), 512-523.

Raykov, T., & Marcoulides, G. A. (2006). *A first course in structural equation modeling* (2nd ed.). Lawrence Erlbaum Associates Publishers.

Roblyer, M. D. (2006). Online high-school programs that work. *The Education Digest, 72(*3), 55.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Free Press.

Sánchez-Prieto, J. C., Hernández-García, Á., García-Peñalvo, F. J., Chaparro-Peláez, J., & Olmos-Migueláñez, S. (2019). Break the walls! Second-order barriers and the acceptance of mLearning by first-year pre-service teachers. *Computers in Human Behaviour, 95*, 158-167. https://doi.org/10.1016/j.chb.2019.01.019

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education, 128*, 13-35. https://doi.org/10.1016/j.compedu.2018.09.009

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of educational research, 79(*2), 625-649. https://doi.org/10.3102/0034654308325896

Taherdoost, H. (2018). A review of technology acceptance and adoption models and theories. *Procedia Manufacturing, 22*, 960–967. https://doi.org/10.1016/j.promfg.2018.03.137

Taylor, S., & Todd, P. (1995). Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *International Journal of Research in Marketing, 12(*2), 137-155. https://doi.org/10.1016/0167-8116(94)00019-K

Toledo, C. (2005). A five-stage model of computer technology infusion into teacher education curriculum. *Contemporary Issues in Technology and Teacher Education, 5(*2), 177-191.

Tondeur, J., Valcke, M., & Van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning, 24(*6), 494-506. https://doi.org/10.1111/j.1365-2729.2008.00285.x

Triandis, H. C. (1980). *Values, attitudes, and interpersonal behavior*: H. Howe & M. Page (Ed.), Nebraska symposium on motivation (s.195-295). University of Nebreska Press.

Ursavaş, Ö. F., Şahin, S., & McIlroy, D. (2014). Technology acceptance measure for teachers: T-TAM. [Öğretmenler için teknoloji kabul ölçeği: Ö-TKÖ]. *Eğitimde Kuram ve Uygulama [Journal of Theory and Practice in Education]*, *10*(4), 885-917.

Vanderlinde, R., & van Braak, J. (2010). The e-capacity of primary schools: Development of a conceptual model and scale construction from a school improvement perspective. *Computers & Education, 55(*2), 541-553. https://doi.org/10.1016/j.compedu.2010.02.016

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science,* 46, 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, G. M., Davis, B. G., & Davis, D. F. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478. https://doi.org/10.2307/30036540

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and research agenda on interventions. *Decision Sciences, 39*(2), 273-315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Wang, Q. (2008). A generic model for guiding the integration of ICT into teaching and learning. *Innovations in education and teaching international, 45(*4), 411-419. https://doi.org/10.1080/14703290802377307

Wang, Q., & Woo, H. L. (2007). Systematic planning for ICT integration in topic learning. *Educational technology & society, 10(*1), 148-156.

Yang, Y., & Wang, X. (2019). Modeling the intention to use machine translation for student translators: An extension of Technology Acceptance Model. *Computers & Education, 133*, 116-126. https://doi.org/10.1016/j.compedu.2019.01.015

About the Author

Nazire Burcin Hamutoglu (Corresponding author); nbhamutoglu@eskisehir.edu.tr; Eskisehir Technical University, Turkey; https://orcid.org/0000-0003-0941-9070

Suggested citation:
Hamutoglu, N. B. (2021). Testing the effects of technological barriers on high school teachers' role in technology integration. *Asian Journal of Distance Education, 16*(1), 74-89.
https://doi.org/10.5281/zenodo.4661743