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A Diachronic View into an Understanding of Technology Acceptance: Where to Go through TAM for Teacher Education from Global to Local?

Rabia Ölmez[1], Nurdan Kavaklı Ulutaş[2]
[1] *Izmir Demokrasi University. e-mail: rabiaolmez2606@gmail.com*
[2] *Izmir Demokrasi University. e-mail: nurdankavakli@gmail.com*

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ABSTRACT

Technology acceptance is rooted at the center of the growing body of research in lieu of education, educational technology, and teacher education. This is mainly occupied with the idea of integrating technology into the classroom setting in order to trigger learners to be advanced in higher-order thinking skills and be digitally literate in order to cope with the challenges of the information era. In doing so, teachers, as the gatekeepers of technology in the classroom, are renowned to be vital sources to deliver information. Thus, it is of critical importance to detect whether teachers are accepting technology with ease and as useful, which can be explained through the technology acceptance model (TAM). That said, this study adopts a diachronic view into an understanding of the role of TAM in teacher education. Accordingly, the aim of this article is to provide an overview of the lay of the land for the development of TAM together with the theories and variables beneath it by means of a review of existing literature. Conceptualizing where to go by means of a top-down approach from global (worldwide) to local (the Turkish context), this article scrutinizes the following results: (1) since new-age learners are expected to develop 21st-century skills, it is today's necessity for future teachers to develop their knowledge and skills in technology; (2) this, in turn, holds the requirement for new teacher education programs to renew the already existing curriculum by providing multimodal learning and teaching environments; (3) herein, understanding how teachers perceive ease of use and usefulness of technology in order to employ it in the classroom environment is of critical importance to trigger teachers' technology adoption through TAM as a credible model; however, TAM somehow falls short of unveiling what it means to adopt and integrate technology in classroom settings, though.

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1. Introduction

Pervading almost all areas of society, technology has its roots in education in two alternates: (1) education systems are integrating digital competencies and various technologies in their curricula, and even assessment types (Beller, 2013); and (2) teachers and teacher educators are stimulated to utilize and/or integrate technology in the classroom environment in order to ease the teaching and learning process, or as an alternative way of formative assessment (Kavaklı Ulutaş, 2023). This has paved the way towards meaningful integration of technology into education with the designated aim of education to raise digitally literate students as future global citizens who can cope with complexities of the society. Thus, a growing body of research has tried to explain the factors mingling with the inclusion of technology and teachers' technology adoption (Hancı-Azizoğlu & Kavaklı Ulutaş, 2021a, 2021b; Kavaklı Ulutaş & Hancı-Azizoğlu, 2021).

Since education has always embraced tension to foster creativity, change, and continuity, in this vein, technology brings great challenges for educational institutions to give a response to all. In the meantime, technology is evolving so rapidly in many parts of the world, and new terms (i.e., digital native) are coined as a remarkable feature of our lives. That said, we create, co-create, benefit, and disseminate knowledge by nestling technology. But it remains blurred whether the teachers are qualified enough to integrate technology into their classroom settings, and even more, technological applications in schools are changing by varying degrees (Bishop & Spector, 2014).

As it is still questionable to what degree teachers integrate technology into classrooms as a complex phenomenon, emerging technology use in teacher education has blossomed recently, which, in turn, provokes the awakening of a problematic area of technology adoption and acceptance. In doing so, the educational landscape is featured by a dominant paradigm known to be the Technology Acceptance Model (hereafter: TAM). TAM is constituted by different variables to explain the behavioral intention and use of technology both directly and indirectly by means of perceived ease of use, perceived usefulness, attitudes towards technology, and the like. Some external variables are also added, such as self-efficacy, teacher knowledge and skills, subjective norms, and facilitating conditions of using technology.

Gaining such momentum thanks to its transferability into different contexts with ease, its potential to simplify the understanding of technology adoption and use has been given prominence by means of a myriad of research conducted in literature by differing modeling frameworks, which all contribute to the understanding of TAM, and accepting it as a powerful vehicle to explain teachers' technology adoption juxtaposed to other models (Kartal et al., 2022).

However, the existing body of research does not indicate a clear picture of the variations of TAM, variables of TAM, and a systematic synthesis of TAM within the scope of education (Kavaklı Ulutaş & Ölmez, 2021). To the best knowledge of authors, it is, therefore, important to synthesize the existing findings in lieu of teacher education utilizing TAM in order to provide an insight into the possible fits behind technology adoption and acceptance in the field of education.

2. Literature Review

There have been numerous frameworks and models in literature which were proposed to explain a user's acceptance of a computer system. The most prominent and phenomenal of these was the Technology Acceptance Model (TAM) introduced by Davis in 1985 in his doctoral thesis at the MIT Sloan School of Management. The core conception of this model was that a user's motivation to use a certain system was the main impetus for whether that system was going to be accepted or refused. The motivation to use a system was predicated to be influenced by the external stimulus corresponding to the features and capabilities of the system.

Following this conceptual framework, Davis built on his ideas and proposed the first Original TAM in 1986. He suggested that the user's attitude towards computer usage was mainly determined by three major constructs: 'perceived usefulness' (hereafter: PU), 'perceived ease of use' (hereafter: PEU), and 'attitude toward using' (hereafter: ATU). The ATU construct was marked to be mainly affected by the PEU and PU constructs. It was also pointed out that PEU was highly likely to have a direct impact on PU whereas PU did not have that on PEU. Lastly, it was highlighted that these constructs were shaped according to system design characteristics shown in Figure 2 as X1, X2, and X3.

According to Davis (1986), technological acceptance of persons is of critical importance in determining the failure or success of a given computer system, and, the main determinant of this acceptance is the ATU of the individuals, and it is accompanied by PEU and PU. The origins of TAM have its roots in the Theory of Reasoned Action (hereafter: TRA). Davis (1986) refined the essence of this theory and combined it with his own ideas leading to the emergence of this paradigm, as elaborated in detail below.

3. The Lay of the Land: Theories behind TAM

3.1 The Theory of Reasoned Action (TRA)

The original TAM originated from TRA. According to TRA, the behavioral intention of a user toward a system is mainly determined by their attitudes toward that system. Thus, it is hypothesized that intention is foreseen finest by behavior. The model asserts that volitional behaviors are influenced by behavioral intentions, and they are the outcomes of both the attitudes and the subjective norms linked with that behavior.

Accordingly, 'attitude' is defined as the feeling(s) of an individual towards a specific behavior, and the 'attitudinal beliefs' and 'outcome evaluations' are substantive for the measurement of the attitudes. The second main construct "subjective norm" (hereafter: SN) is defined as the opinion(s) of the individuals' significant others about whether they should perform that behavior. The TRA model indicates that 'normative beliefs', which include the expectation of certain people or groups, and 'motivation to comply' are the factors constituting the SN construct.

According to TRA, it was proposed as a formula to calculate the behavioral intention of an individual as follows:

$$BI = AB\,(W1) + SN\,(W2)$$

In the formula, BI represents the behavioral intention to perform that behavior, AB stands for the attitude toward the behavior, and SN corresponds to the subjective norm as indicated earlier. W1 and W2 represent the weights of these factors. Based on this formula, it is stipulated that the sum of the attitudes toward the behavior and the subjective norm comprises the behavioral intention of an individual which leads to the performance of actual behavior. Davis (1986) also asserts that TRA could be applicable to illustrate that behavior but there are certain necessary adjustments to be made in TRA.

In 1989, Davis argued that it could be possible the system could be perceived as useful leading to the intention to use that system without any attitudes. He added that attitude may not be crucial in the determination of intention since usefulness as a factor might surpass the impact of attitudes on intention to use in several settings, such as the workplace. Moreover, Davis et al. (1989) performed an analysis on the comparison of TRA and TAM and acknowledged that the implementation of TAM was much more effortless and less costly compared to TRA on the grounds that measurement of the 'beliefs' as a construct in TRA required a range of salient belief to be formed, yet the construct was context-independent in TAM. On this wise, Davis added to the model by making changes and developed the first modified version of TAM.

3.2. The First Modified Version of TAM

Upgrading TRA with constructs, it was pointed out that the system might be perceived as useful; however, when the system was too difficult to use, the usefulness of the system was outweighed by the factor of easiness (Davis, 1989). Thus, Davis eliminated the construct of SN from TRA model, and he centralized on determining two main constructs: PU, and PEU. Venkatesh and Davis (1996) asserted that "in order to be able to explain user acceptance and use, it is important to understand the antecedents of the key TAM constructs, perceived ease of use and usefulness." (p. 743). These two factors, therefore, were remarked to be the most paramount constructs in explaining technology acceptance (Chen & Chang, 2013), and described as follows:

- "*Perceived usefulness; the degree to which a person believes that using that system will improve their performance or job.*
- *Perceived ease of use; the degree to which a person believes using that system will be easily performed both physically and mentally.*" (Davis, 1985, p. 320)

The conception giving rise to the first modified version of TAM was that the PEU, PU, and attitudes towards use (hereafter: ATU) affected behavioral intention (hereafter: BI) directly and indirectly. Besides, while both PEU and PU mutually affected ATU, PEU had a direct impact on PU implying that when the system was perceived as easy, it was likely to be perceived as useful, as well (Davis, 1989).

Correlatively, Davis et al. (1992) conducted a study on the analysis of TAM in order to examine the conjoint direct and indirect effects of the two variables, namely PU and PEU, and the regression analysis revealed that the relationship of actual system usage with PU was high whereas it remained low with PEU. This implied that users were able to handle some difficulties they encountered while using the system if they perceived that the system's functionality was of critical importance. Yet, if there was no use or functionality in using that

system, there was no amount of easiness that could compensate which emphasized the robustness of PU factor in the model (Davis et al., 1992).

Following this, Davis (1993) analyzed the direct and indirect effects of the PEU and PU variables retrospectively, and in contrast to what he presumed earlier, he concluded that PEU might have a direct impact on PU. He hypothesized that the main reason for this was PU was related to the long-term impact of a system's usage on job performance (outcome). As an individual was likely to acquire while PEU was concerned with the process of using the system itself (process), it might have a greater impact on behavioral intention to use. Thus, it was speculated that a system's amount of usefulness fell short in explaining the behavioral the intention of a user since the system was not used when it was perceived as difficult, which was also indicated in the model, as well.

Furthermore, the model underlines that individuals' PU and PEU were affected by certain external factors, such as training, computer self-efficacy, and system design characteristics (Davis, 1993). TAM with specified external factors foresaw the utilization of technology and, also presented a justification of why a specific system might not be adopted in order that researchers might "pursue appropriate corrective steps" (Davis et al., 1989, p.985). Herein, Davis (1993) also suggested that there should be further studies conducted to detect the 'external variables' affecting PU and PEU.

In search of external variables, the analysis of Davis et al. (1992) on the motivation factor within TAM uncovered that both extrinsic and intrinsic factors played a significant role in determining the behavioral intention to use new technology. According to this analysis, when the individuals regarded technology as useful, they had the extrinsic motivation to use it, and when they had personal enjoyment using the system, they had intrinsic motivation to use it (Davis et al., 1992). On this basis, it might be suggested that when the system had a high level of perceived usefulness, it had a more significant impact on behavioral intention than the ones with no enjoyment. The significance of external variables was also acknowledged in the literature. Consequently, this version of TAM had been accepted as the final original TAM in literature and utilized as a framework within various contexts and disciplines.

3.3. Final Modified Version of TAM

Prior to the development of the final version of TAM, Davis (1993) asserted another claim contradictory to his previous estimations and pointed out that PU might also be directly conducive to actual system usage. In addition to this, he detected that system characteristics might directly impact the individuals' ATU. Consequently, another formulation of TAM emerged.

Davis et al. (1989) conducted a longitudinal study taking the first modified version of TAM as a framework to examine the participants' intention to use a system right after an hour of introduction and after the following 14 weeks. They concluded that the most influential and significant factor affecting the intentions of participants was PU. Nonetheless, their examination also indicated that the impact of PEU was small, yet it had a substantial effect on BI which decreased over time. The crux of this study was that both PU and PEU could have a direct impact on BI which necessitated the exclusion of the ATU construct from the model contributing to the development of the final version of TAM (Venkatesh & Davis, 1996).

The exclusion of ATU construct from the model provided a justification for the direct influence of PU on the actual system usage, and probably, the unknown impact of system characteristics on ATU. In addition to this, the external variables were highlighted to be crucial determinants of both PEU and PU since they might affect the beliefs of individuals about the system. In the model, external variables consisted of user training, user participation in design, the features of the implementation process, and system characteristics. Thus, the change in the model was the inclusion of the system characteristics factor under the category of external variables construct contrary to its former position as a single construct per se.

A myriad of studies in literature focused on the two main constructs, namely PEU and PU, and their relationships with external factors. Firstly, 69% of the variance in attitude toward computer use among pre-service teachers studying at the National Institute of Education in Singapore was revealed to be defined by PU construct (Teo & Schalk, 2009). It was also demonstrated that PU affected the Singaporean and Malaysian pre-service teachers' intention to use technology directly (Teo et al., 2008). As PU, the PEU construct was spotted to be the main determinant of attitudes and intentions to use technology (Teo, 2009). Contrary to these findings, a meta-analysis of 1826 publications on technology acceptance of pre-and in-service teachers discovered that the impact of BI construct was weightier than PU and PEU due to its direct and indirect impact on actual use. This meta-analysis also highlighted that TAM was evenly applicable to various sub-groups involving pre-and in-service teachers, and teachers from different educational levels and backgrounds (Scherer et al., 2019).

Additionally, Venkatesh (2000) detected that PEU affected six external variables positively and argued that the discovery of the mediating effects of external variables on the two main constructs PU and PEU was a momentous contribution since the research on this matter had been limited in the literature. Even though the researchers aiming at extending TAM were mostly interested in the relationships amidst external variables and the two main constructs PU and PEU, there were many other factors implemented to TAM in literature.

It was reported in the literature by a meta-analysis covering the years from 1998 up to 2003 that variables applied to TAM were marked as relative advantage, voluntariness, complexity, compatibility, trialability, observability, self-efficacy, image, objective usability, end-user support, computer playfulness, personal innovativeness, subjective norms/ social influence, social presence, job relevance, visibility, accessibility (physical accessibility and information accessibility), computer attitude, result demonstrability, computer anxiety, perceived enjoyment, management support, system (output or information) quality, prior experience, facilitating conditions (Lee et al., 2003). Another meta-analysis of 107 studies revealed that 152 external factors were utilized within TAM; however, it was identified that only five of them (i.e., subjective norm, self-efficacy, computer anxiety, prior experience, and enjoyment) were detected to be related to TAM in more than ten studies. Additionally, it was pointed out that PEU was predicted at most by regarding the e-learning systems was self-efficacy, and subsequently, enjoyable experience, computer anxiety, and subjective norm while it was enjoyment, followed by subjective norm, self-efficacy, and experience for PU (Abdullah & Ward, 2016). The experience variable was viewed as "the best-studied moderator variable in TAM" by King and He (2006, p. 747).

Besides, TAM was remarked to be capable of explaining about 40% of a system's use (Legris et al., 2003) and predicting the behavior of information systems' acceptance within different technologies and uses (Lee et al., 2003). The application of the TAM in various disciplines, contexts, and participant groups with myriad variables necessitated the extension of the model so that it could be implicated more extensively. One of the most substantial developments of TAM was brought by Venkatesh and Davis (2000) proposing a further model, renowned to be TAM2.

3.4. Technology Acceptance Model 2

The primary objective of TAM2 was to retain the original constructs of TAM and "to include additional key determinants of the TAM's PU and BI constructs, and to understand how the effect of these determinants changed with increasing users' experience over time with the target system" (Venkatesh & Davis, 2000, p.187). Thus, it was introduced in the model that the main reason for an individual's perceiving a system as a user could not be explained in TAM which was a critical limitation to be handled. Hence, TAM2 aimed at investigating the probable reasons affecting PU.

The variables that had an impact on PU in TAM2 consisted of subjective norm, image, job relevance, output quality, and result from demonstrability. The 'image' construct in the model referred to the aspiration of a user to maintain behaviors approved by his significant others, 'job relevance' to the applicability extent of a technology, 'output quality' to the degree of a technology's satisfactory accomplishment of the demanded tasks and lastly, 'result demonstrability' to the production of evident results (Venkatesh & Davis, 2000). Additionally, the 'voluntariness' and 'experience' constructs were pointed out as moderating factors of the subjective norm.

Accordingly, SN construct had an influence on the image construct, suggesting that when people around the individuals approved or disapproved of certain behaviors regarding the technology, the image portrayed by the individuals was impacted, as well. In TAM2, the additional constructs were categorized into two as social influence processes and cognitive instrumental processes. Accordingly, it was claimed that four cognitive factors, namely job relevance, result demonstrability, output quality, and PEU could affect PU while the other three social drives having an impact on PU were subjective norm, image, and voluntariness.

Following the proposal of TAM2, Venkatesh and Davis (2000) attempted to test the performance of TAM2 in mandatory settings because the construct of PU and PEU might fall under the influence of obligatory usage of technology at certain settings. Thus, they conducted a field study with 156 knowledge workers. The participants used four different systems and, two of these systems were for voluntary use whereas the other two were mandatory. Moreover, the data were collected from the participants at three points in time: pre-implementation, one- month post-implementation, and three-month post-implementation. The study results revealed that TAM2 was observed to operate well in two environments. Yet, it was detected that the impact of SN in voluntary settings was non-existent while it was evident in mandatory settings.

The development of TAM2 was a significant extension of the original TAM in the field. Subsequently, a second extension of TAM2 by Venkatesh (2000) arouse. Venkatesh pursued to analyze the antecedents of PEU which was not the focus of TAM2. Accordingly, he

determined two main antecedent groups of PEU: anchors and adjustments. 'Anchors' were viewed as common ideas about computers and computers usage and, 'adjustments' referred to the beliefs that emerged according to the accustomedness to the target system. Various determinants formulated from the previous research on the PEU's antecedents of Davis et al. (1992), and Venkatesh and Davis (1996) were included. As depicted, the anchors consisted of four variables (i.e., computer self-efficacy, perceptions of external control, computer anxiety, and computer playfulness) and adjustments involved two variables (i.e., perceived enjoyment and objective usability). Venkatesh (2000) hypothesized that all these variables in both groups had a direct impact on PEU, and thus, an indirect impact on PU and BI.

For the confirmation of his hypothesis, Venkatesh (2000) conducted an analysis in three different settings with 246 participants over a three-month period by utilizing three different measures, and, the results acknowledged that the extended variables in the model were robust in explaining PEU for a certain system. Hence, the development of the model continued perpetually in literature. Another novelty in the development of TAM was the development of the Unified Theory of Acceptance and the Use of Technology Model (UTAUT) by Venkatesh et al. developed in 2003.

3.5. Unified Theory of Acceptance and Use of Technology (UTAUT)

The model, UTAUT, proposed by Venkatesh et al. (2003) was distinct from the other models of TAM introduced previously due to the fact that it was not one of the models which were developed through add-on variables; yet, it emerged as a result of the review and integration of eight dominant theories related to the technology acceptance and usage, which were: the Theory of Reasoned Action (TRA), Motivational Model, Technology Acceptance Model (TAM), a combined TBP/TAM, Model of PC Utilization, Theory of Planned Behavior (TPB), Social Cognitive Theory (SCT) and Innovation Diffusion Theory (IDT). The primary focus of this model was to explain the users' intentions to use technology and consequent usage behavior.

There were seven comprising factors in the UTAUT model having an impact on the technology acceptance. Five of these factors were already existent in previous models, and they were performance expectancy (hereafter: PE), effort expectancy (hereafter: EE), social influence (hereafter: SI), and facilitating conditions (hereafter: FC). The fifth factor, 'attitude' was eliminated from the model due to the hypothesis that only four components were the predictors of behavioral intention. The other two factors, self-efficacy, and anxiety were retrieved from Social Cognitive Theory.

It was also highlighted in the model that EE was more notable in women than men; thus, in addition to these variables, four other moderating variables were included in the model: age, gender, perceived voluntariness to use it and experience with the technology. It was hypothesized that the mediator impact of these variables was the determinant of four main predictors of behavioral intention, and FC would have a substantial impact on users when moderated by experience and age. Lastly, Venkatesh and Davis (2000) alleged that SI had an influence on individuals through three mechanisms: compliance, internalization, and identification.

Even though the significance of intrinsic motivation, also defined as perceived enjoyment, in technology acceptance was formerly regarded as prominent (Davis et al., 1992), it was excluded from the framework in the UTAUT model since it was argued that its impact on the

acceptance was surpassed by the mediator factors in the model. The UTAUT model may be potent in explaining technology acceptance. Yet, behavioral intention to use technology was detected to be explained with around 70 percent of the variance, and about 50% of technology use was highlighted to be explained by the UTAUT model (Venkatesh et al., 2012).

The application of UTAUT was more in industrial settings regarding consumers' acceptance of a technology or a computer system; nonetheless, there was recent research on the application of UTAUT in educational settings that inspect the schoolteachers' technology use and acceptance (e.g., Teo, 2011; Teo, 2012; Teo & Wong, 2013). According to Venkatesh and Bala (2008), the necessity of the applicability of the model in different settings with various participant groups required the addition of TAM's PEU and 'usage intention' constructs to the framework. Based on this claim, they proposed a new model: TAM3.

3.6. Technology Acceptance Model 3 (TAM3)

Venkatesh and Bala (2008) integrated TAM2 (Venkatesh & Davis, 2000) with the PEU's determinants (Venkatesh, 2000) by suggesting that the determinants of PEU did not have any impact on the determinants of PU. TAM3 included four major constructs that had an influence on the determinants of both PEU and PU, which were: social influence, facilitating conditions, individual differences, and system characteristics. The main hypothesis of this model was that experiences were the moderators of the relationships between PEU and PU, PEU and computer anxiety, and, PEU and BI.

The relationship between PEU and PU in TAM3 was explained as:

> "… with increasing experience, the influence of PEU (low-level identity) on PU (high-level identity) will be stronger as users will be able to perform stronger as users will be able to form an assessment of their likelihood of attaining high-level goals (i.e., perceived usefulness) based on information gained from the experience of the low-level actions (i.e., perceived ease of use)" (Venkatesh & Bala, 2008, p. 281).

The researchers, thereby, conducted a longitudinal field study at four different organizations for the validation of the framework and provided empirical evidence on the relationships and cross-effect of the constructs' determinants on one another (Venkatesh & Bala, 2008). They concluded that "the key strength of the TAM3 is comprehensiveness and potential for actionable guidance" (p. 301). Yet, the application of this framework was context-based; thus, it was applicable to workplace settings mostly. In this vein, the follow-up research on the model did not cease in the literature. The last development and extension of the framework were the UTAUT2 Model proposed by Venkatesh et al. in 2012.

3.7. Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

Following the development of several hypotheses and the introduction of new frameworks based on the previous research in the field, the researchers kept seeking the improvement of TAM and they aimed at adapting it to certain contexts. Bearing these in mind, the primary objective of the UTAUT2 Model was to address consumer use context. With this objective, Venkatesh et al. (2012) proposed the UTAUT2 Model by adapting the constructs and their definitions to consumer technology acceptance and use. Apart from these constructs, they

added three more constructs to the model which were 'hedonic motivation', 'price value', and 'habit'. As promoted earlier, they hypothesized that all the other constructs of UTAUT and the latterly added ones had a direct impact on BI and usage, and the variables such as age, gender, and experience affected the three newly promoted variables, and the facilitating conditions construct.

The adaptation of the former UTAUT constructs to the consumer use context brought new adapted definitions to the constructs, as well. Accordingly, the former constructs with new definitions were pointed out as follows:

> *- "Performance Expectancy; the degree to which using technology will provide benefits to consumers in performing certain activities,*
>
> *- Effort Expectancy; the degree of ease associated with consumers' use of technology,*
>
> *- Social Influence; the extent to which consumers perceive those important others (e.g., family and friends) believe they should use a particular technology,*
>
> *- Facilitating Conditions; consumers' perceptions of the resources and support available to perform a behavior"* (Venkatesh et al., 2012, p. 159).

To conclude, there has been a great body of research and investigation in literature which were dedicated to the development and extension of TAM by analyzing the relationships of the constructs with one another, validating, and justifying the proposed frameworks or add-on constructs, and hypothesizing new relations or formulas in the model. Several scholars have attempted to extend the application of TAM into different settings, various participant groups, and numerous contexts which has led to the TAM being the most parsimonious framework being utilized in technology acceptance and usage studies worldwide. Thus, previous research on TAM in lieu of teacher education is elaborated below in detail from global to local context(s).

4. Previous Research on TAM and Teacher Education: From Global to Local

The studies conducted on TAM in relation to teacher education including pre- and in-service teachers have been diverse in terms of the contexts and the participant groups involved. Most of the research on this subject matter was conducted in Asia where the "Technology Acceptance Measure for Pre-service Teachers Scale" was first introduced. There were also several other studies conducted in the Western context with pre-service teachers, as well. It is worth noting that studies performed worldwide included pre-service teachers studying in different departments.

To elaborate on previous studies on TAM, those performed with pre-service teachers had been the focal point of teacher education studies in Asia. Scholars had long debated the impact of TAM constructs on the BI and technology acceptance of pre-service teachers. For instance, Teo et al. (2008) conducted research to make an analysis of the Computer Attitude (hereafter: CA) of 239 pre-service teachers in Singapore through the administration of the TAM model and revealed that the pre-service teachers' main determinant of CA was the PU and PEU, both having a direct impact on their CAs. Their study also highlighted that even though SN had a direct and indirect influence on the CA, its influence on the PU was stronger. This result confirmed the study findings of Davis et al. (1989) pointing to the robust influence of the SN on pre-service teachers' CA.

Following these, Teo and Van Schalk (2009) performed a study on the technology acceptance of pre-service teachers in Singapore with 250 pre-service teachers and supported the findings of Teo et al. (2008) in that PU was the main determinant of BI of pre-service teachers' technology acceptance. However, their study contradicted with the findings of Teo et al. (2008) in several other ways such as it demonstrated as PEU not having a direct impact on BI, yet it impacted FC and PEU directly. More importantly, Teo and Van Schalk (2009) found that SN did not have any impact on PU, and there was no relation between the CAs of pre-service teachers and their BI to use technology.

The issue of the main determinants of BI and technology acceptance of pre-service teachers had been a controversial and highly disputed subject within teacher education studies. For example, research conducted in Asian context with pre-service teachers, applying a different framework and scales other than TAM, had the same conclusion as the previous studies by reporting that even though pre-service teachers had positive attitudes towards web 2.0 technologies' integration in the classroom and they were active users of social networking sites, they found teaching with technology to be complex by having reserved attitudes towards it (Lei, 2009). The findings of this study could be interpreted within the TAM framework as PEU being the main determinant of pre-service teachers' technology acceptance or their BI to use it in their teaching practices.

Similarly, Teo (2011) argued that Malaysian pre-service teachers were more likely to use technology when they perceived it useful, and it would enhance their job performance. The researcher also reported that PEU had an indirect impact on BI and affected both PU and ATU. This finding suggested that pre-service teachers did not merely accept a new technology just because it was perceived to be easy, but it was necessary to have a positive attitude towards it, and perceive it as useful, as well. Lastly, Teo (2011) concluded that BI to use technology was found to be mostly predicted by computer self-efficacy conveying that when pre-service teachers regarded themselves as competent in technology use, they were more likely to use it.

As mentioned earlier, numerous studies in the Asian context have investigated the interrelations between the TAM constructs with pre-service teachers. More recent research on this subject matter, performed with 302 pre-service teachers in Malaysia, was contradictory to the findings of Teo et al. (2008), Teo (2011), and Lei (2009) with the claim that PU and ATU had a direct impact on pre-service teachers' technology integration in their teaching, the latter showing less variance, whereas PEU was not a significant determinant of BI and ATU, yet it was detected to be a predictor of PU (Wong, 2013).

Following this, more recent attention has focused on the gender differences in technology acceptance among pre-service teachers. Teo et al. (2015) studied the gender difference in technology acceptance at a teacher training institute with 339 pre-service teachers and discovered that there was no statistically significant gender difference in the PU, ATU, and BI constructs suggesting that pre-service teachers from both gender groups had equal perceptions about the usefulness of technology, attitudes towards technology use and intentions to use it in their teaching. This was also extended to online education platforms to explore learners' intention to use technology in the Asian context (Zhou et al., 2022), mobile augmented reality in education through an extended TAM (Papakostas et al., 2022), and a

ChatBot for learning a foreign language to investigate learning achievement and technology acceptance (Chen et al., 2020), as well.

While numerous studies attempted to explain the technology acceptance of pre-service teachers, the measurement tools for those investigations had been limited to those developed for individuals in different business sectors, in-service teachers etc., and not developed specifically for pre-service teachers. However, it was not until the development of a scale for pre-service teachers that the studies on this subject matter diversified worldwide. Teo (2010) developed the five-factor scale, which are PU, PEU, SN, FC, and ATU, "Technology Acceptance Measure of Pre-service Teachers" (hereafter: TAMPST) drawing from various theoretical frameworks introduced in information systems and technology acceptance by using three studies with 759 pre-service teachers. Subsequently, Teo (2015) performed another analysis on the technology acceptance with 387 pre- and 430 in-service teachers and proposed a new 7-point scale with seven variables which are PU, PEU, ATU, SN, FC, Computer Self- Efficacy (hereafter: CSE), and Technological Complexity (hereafter: TC). The results of the analysis revealed that all these seven variables were valid in explaining technology acceptance among both teacher groups, yet FC and TC were detected to be more significant in predicting technology acceptance.

Although the investigation of technology acceptance or technology integration had been a prominent research area in the Turkish context, the investigation of this subject matter with pre-service teachers under the TAM frameworks had not been abundant. In terms of educational technology acceptance and integration, there were few studies conducted with

in-service teachers (Akar, 2019; Göktaş et al., 2008), and the participant groups of the studies with pre-service teachers were distributed among numerous departments in Turkey, as a signpost of local context.

To illustrate, Özdamlı et al. (2009) investigated the attitudes of pre-service teachers from several departments, including English Language Teaching, towards educational technologies and reported that participants from all branches had an agreement on the positive effect of educational technologies with no statistically significant gender difference. Similarly, Efe (2011) examined science pre-service teachers' beliefs and intentions of educational technology use in instruction and revealed a high correlation between educational technology experience and intention to use it in future classrooms. Furthermore, Koc (2013) inspected on the technology conceptions of 237 technical pre-service teachers in Turkey through a metaphor analysis and highlighted that they had restricted conceptions, mostly centered on technical dimensions, albeit with no significant gender difference in educational technologies.

There had been few empirical investigations on the relationship between the technological/ computer competencies and the attitudes towards technology use among pre- service in the Turkish context. For example, Çetin et al. (2012) conducted research with 642 pre-service teachers from several departments in Turkey. The researcher reported the technology competency level of pre-service teachers was at an average level and they had positive attitudes toward educational technology use in instruction. A more recent study inspected the relationship between computer competence, attitudes towards computer-assisted education (hereafter: CAE), and technology acceptance intention of 476 pre-service teachers from various departments within three dimensions of TAM (PU, PEU, and perceived

enjoyment), and found a statistically significant relationship among these three subjects. It was also reported in the study that three dimensions of the TAM had a significant relation with attitude towards CAE, PEU not being a determinant of attitudes towards CAE, and females were detected to have a higher level of technology competence (Baturay et al., 2017). Lastly, Baydas and Goktas (2017) proposed a model for the analysis of pre-service teachers' ICT usage intentions in future lessons under the UTAUT framework. Their study acknowledged that PU, PEU, and efficacy were intermediate factors in determining ICT usage intentions whereas they were all affected negatively by computer anxiety, which in turn, indirectly impacted BI.

So far, there had been some investigations on the technology acceptance, attitudes toward technology integration, and the technology competence of pre-service teachers in the Turkish context; however, they did not deal with pre-service EFL teachers. The number of studies on the technology acceptance of pre-service EFL teachers in Turkey had been limited in the literature.

To elaborate, İlter (2015) analyzed the perceptions of pre-service EFL teachers and young learners on technology use qualitatively and reported that participants agreed on the positive effect of technology in the language learning process. On the other hand, there were two other studies performed with 241 pre-service EFL teachers in Turkey within the TAM framework. The first one (Bozdoğan & Özen, 2014) examined the level and competence of ICT usage and the factors having an impact on the ICT self-efficacy levels of pre-service EFL teachers in Turkey. The study acknowledged that the ICT self-efficacy levels of most of the participants were high, and the supportive and dynamic nature of ICTs was positively impactful on their ICT integration (Bozdoğan & Özen, 2014). The study also underlined that knowledge and skills were the main determinants of ICT integration of pre-service teachers in their future teaching.

The second study (Kırmızı, 2014) investigated the technology acceptance of 213 pre-service EFL teachers in Turkey within the TAM framework and revealed that pre-service EFL teachers had positive awareness of PEU, FC, ATCU technological complexity, computer self-efficacy, and BI. It was also reported in the study that there were statistically significant differences between first and fourth-grade students regarding PEU, FC, ATCU, and computer self-efficacy. Lastly, PEU was detected not to be a determinant of BI, which is in line with the finding of Wong (2013), and PU to have a positive effect on ATU.

Very recently, Ölmez and Kavaklı Ulutaş (2022) investigated the interrelationship amidst TAM, WPACK, and CDL levels of pre-service English language teachers in order to explain whether technology adoption was discursive in defining higher/ lower levels of Web-Pedagogical Content Knowledge (hereafter: WPACK) and Critical Digital Literacy (hereafter: CDL) in terms of (pre-service) teacher's knowledge. In doing so, 94 Turkish pre-service English language teachers were asked to define levels of TAM, and other variables noted as WPACK and CDL. As a result, it was noted that Turkish pre-service EFL teachers' levels of technology acceptance and critical digital literacy were moderately high whereas their web pedagogical content knowledge levels were detected to be high. Additionally, T-test results highlighted that there was no significant difference in terms of participants' technology acceptance, WPACK, and CDL levels regarding age, gender, and personal computer ownership.

Qualitative data results also provided a deeper insight into participants' perceptions of related concepts by revealing that familiarization with technology and the web, modifications in teacher education programs, and their curricula to help raise their awareness could improve their future teaching in this vein. And this study was one of the pioneers in a local context since it featured all three variables of TAM, WPACK, and CDL, all at once.

Another recent study (Gurer & Akkaya, 2022) purposed the idea that pre-service Math teachers' pedagogical beliefs were more constructivist, albeit not traditional with a significant effect on the components of TAM. In the same vein, these beliefs did not have a direct influence on PU and ATU; however, positive influence on PEU.

In terms of locality, research conducted in Turkey is mostly concerned with computer usage among teachers pinpointing the idea that teachers in Turkey are still struggling in the classroom while using technology (Bayhan et al., 2002); however, recently, this has transformed into an increase in adopting technology since new generation teachers graduate from the faculties of education with higher computer literacy skills and knowledge before they enter into teaching as a profession (Aypay & Özbaşı, 2008).

One more to note, TAM is also identified as a credible model to be used in education by a myriad of studies conducted on a global scale. To mention, Abdullah and Ward (2016) have reviewed 107 articles to examine the most used external variables of TAM within the scope of e-learning adoption by means of a quantitative meta-analysis. Additionally, Weerasinghe and Hindagolla (2017) have reviewed 8 articles related to TAM which have focused on the applications of the model in lieu of the domains of Library and Information Science (LIS) and Education. Another systematic review synthesizes the research studies conducted on TAM within the scope of acceptance of m-learning amidst students concerning the published work between 2006-2018 (Al-Emran et al., 2018). To mention more, Scheret et al. (2019) have reviewed 114 empirical studies in order to clarify the factors that TAM might predict teachers' technology adoption. Recently, Granić and Marangunić (2019) have also systematically reviewed 71 studies between the years of 2003 and 2018 by using EBSCO Discovery Service that has focused on the applications of TAM in the educational context varied in terms of domains of learning, technologies of learning and user types.

5. Conclusion: The Way Towards Language Teacher Education

Technology acceptance as a matter of fact has been occupying literature in terms of using educational technologies and training teachers to employ technological tools for education. This growing interest is mainly shaped by the transformation in lieu of the digital era and knowledge economy. Thus, new-age learners are assumed to develop problem-solving and critical thinking skills by adopting creativity, flexibility, and technology. This, somehow, necessitates future teachers to enhance their knowledge and skills in technology in turn (Kavaklı Ulutaş & Abuşka, 2022).

It is, then, a crystal-clear fact that being familiar with technological tools and products is of utmost importance to lace future students of the digital era with multimodal learning environments; thus, pre-, and in-service teachers are at the core of the chain (Kavaklı Ulutaş & Abuşka, 2023). In this vein, the current study synthesizes the existing body of research from global to local to provide an overview of the model (TAM) together with its utilization in teacher education and to comprehend teachers' technology adoption, which triggers us to

understand how teachers perceive ease of use and usefulness of technology so to employ in classroom settings.

To note, although TAM somehow falls short of unveiling what it means to adopt and integrate technology in classroom settings, the model conceptualizes the variables to provoke professional knowledge about teaching and learning, albeit not specifically. For meaningful integration and adoption of technology, types of teachers' knowledge should also be specified, as well. In today's world and education systems, the understanding of technology and technology literacy is regarded as necessary skills for learners (Milutinović, 2022; Ozyurt & Ayaz, 2022). Teachers as being at the central position in the field of education for the goodness of the next generations, it is essential to possess a higher understanding of related skills, knowledge, and perspectives.

Thus, understanding the components of TAM, which has dominated the research landscape in terms of an individual's technology use, to enlighten the nascent perspectives for teacher education is of critical importance.

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Disclosure of Conflict of Interest

The authors declare no conflict of interest.

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