INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 12, Issue 3, (2022) E-ISSN: 2222-6990

A Review on Adapted Models in Technology Acceptance

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v12-i3/12346 DOI:10.6007/IJARBSS/v12-i3/12346

Published Date: 27 March 2022

Abstract

The 21st century of education has changed the education system, particularly in teaching pedagogy. Technology's incorporation into teaching and learning has become a worldwide phenomenon. This paper aims to review some models that were adapted and extended from the technology acceptance model (TAM). This paper focuses on models tested on practising and preservice educators' acceptance of specific technology. This study uses meta-analysis in reviewing the pattern of adapted models in technology acceptance from 2003 until 2021. Most of the studies resulted in very significant results. The results also suggested that Technology Acceptance Model is a robust model in predicting educators' behavioural intention in using new technology. Technology Acceptance Model can also be adapted and extended to indicate user acceptance in other fields. More extensive review in the adapted model in technology acceptance could be done since there are many other technology acceptance models such as Unified Theory of Technology Acceptance and Use of Technology

Keywords: Technology Acceptance Model, Technlogy-Integrated Learning, 21st Century of Education, User Acceptance, Behavioural Intention

Introduction

Various studies have been conducted worldwide that indicate the tremendous advantages of using technology in education. Since it offers unlimited sources for education, technology-integrated learning has become a preferred way of teaching (Sun & Goa, 2019). Technology is also one of the best communication mediums between educators and learners (Zaki & Yunus, 2019).

Many advancements and modifications have been made in predicting user acceptance of new technology over the last decade (Rahman, Yunus & Hashim, 2019). Scientists have investigated the impact of attitude towards user behaviour since 1918 (Al-Qeisi, 2009). Many technology acceptance models have been established since (Rahman et al., 2021). However,

Technology Acceptance Model (TAM) by Davis et al (1989) is relatively inclusive, and it is the most influential model because it has several empirical evidence (Althunibat et al., 2012). The two main factors in TAM have perceived usefulness and perceived ease of use. These two factors are the determinants in predicting the attitude towards using a specific system or technology, determining the behavioural intention in using the technology. It also generates the actual use of behaviour (Davis et al., 1989). Figure 1 shows the original technology acceptance model by (Davis et al., 1989).

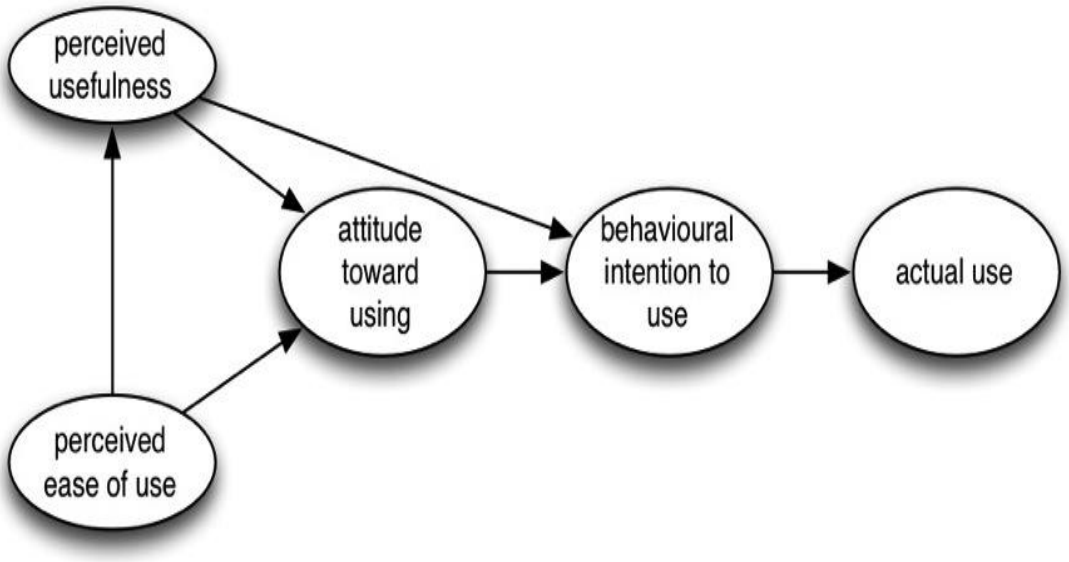

Figure 1: Technology Acceptance Model (Davis et al., 1989)

TAM has been applied in various studies and fields, including business, library sciences, and medical fields (Salman et al., 2014). Therefore, this paper is meant to explore the adapted models from TAM on both practising and pre-service educators.

A Review Models on Practising Educators

Integrating models developed for testing on average consumers into scholastic clients is not a new issue. Hu et al (2003) extended the technology acceptance model a few years ago by improving four different variables: computer self-efficacy, job relevance, subjective norms, and compatibility. A survey was sent to 130 educators participating in a PowerPoint coaching program. The results of the extended model evaluation confirmed that the model was practically appropriate with the data. Furthermore, compatibility had a significant impact on perceived ease of use. Besides, perceived ease of use had an early effect on educator acceptance during the program. Additionally, subjective norms had an opposite effect on perceived usefulness. Hu et al (2003) model's is depicted in Figure 2.

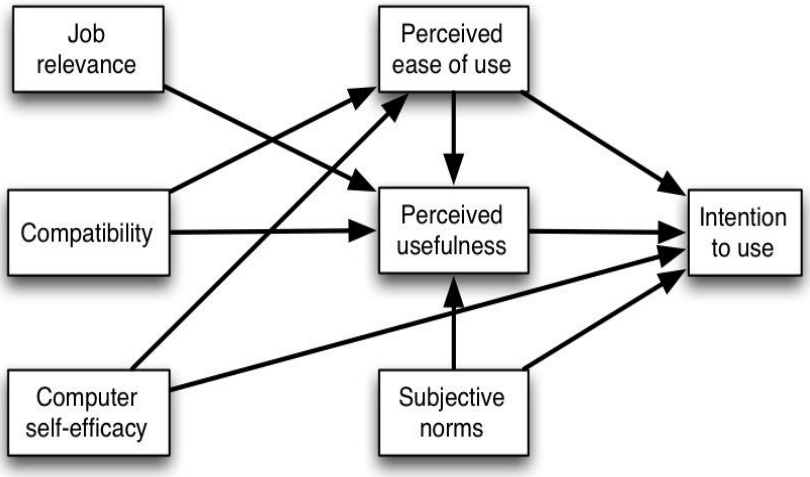

Figure **Error! No text of specified style in document.**: Technology Acceptance Model (Hu et al., 2003)

Vannatta and Banister (2009) proposed an educator technology integration survey to evaluate educators' technology practices by measuring educators' beliefs and behaviours in applying technology in teaching and learning. The Technology Integration Survey (TTIS) encompasses six elements: perceived benefits of using classroom technology; risk-taking behaviour and comfort with technology; principles and behaviours concerning schoolroom technology practise; technology sustenance and approach; educator technology use for teaching, instructional encouragement, interaction, and interaction enablement of student's technology practise. They informed that the perceived remunerations concept (comparable to perceived usefulness) and principles and performances were substantial forecasters of educators' practise of technology in teaching and learning. This outcome expected that perceived usefulness is a significant element in describing the practice of technology.

Additionally, Inan and Lowther (2010) established a model to explore the causes upsetting educators' technology incorporation in K-12 school rooms. The model contained nine variables: years of experience, age, computer availability, computer proficiency, overall support, technical support, educators' beliefs, educators' readiness, and technology integration. The model was examined in Tennessee community institutes among 1,382 educators. Figure 3 shows the propositioned model by (Inan and Lowther, 2010).

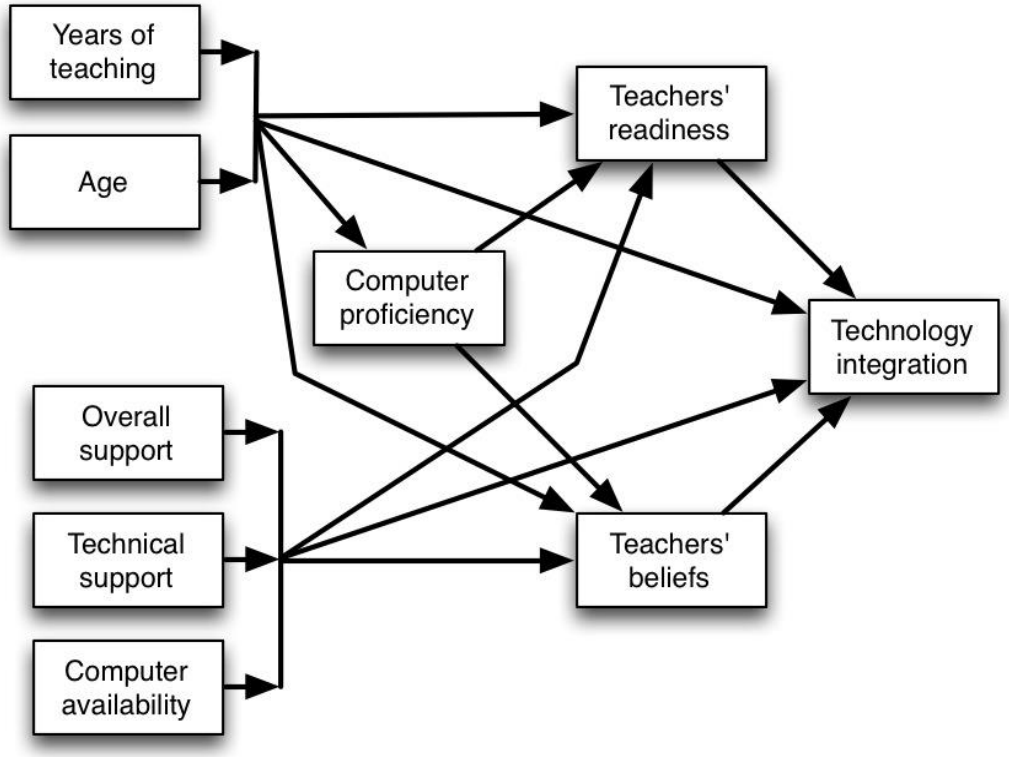

Figure 3: Proposed model (Inan & Lowther, 2010)

According to the findings, all relationships between the variables were significant (Inan & Lowther, 2010). Educators' enthusiasm for using technology in education, related to self-efficacy, was a strong predictor of technology adoption. Wu, Chang, and Guo (2008) created a model by combining three theoretical models: task-technology fit, social cognitive theory, and the technology acceptance model. The event drew 226 Taiwanese scientific educators. The model considered perceived fit, perceived utility, perceived ease of use, computer self-efficacy, and intention (Wu et al., 2008). They testified that computer self-efficacy and perceived utility were essential factors in science instructors' willingness to use technology. The perceived fit significantly influenced both perceived utility and perceived ease of use. Furthermore, computer self-efficacy predicted perceived fit, perceived ease of use, and intention differently than perceived fit, perceived ease of use, and intention.

Nonetheless, perceived usefulness was hampered by the simplicity of usage. Overall, the findings supported the proposed concept (Wu et al., 2008). Finally, Wu et al (2008) recommended that future studies investigate the interactive purpose and actual practice mediators. Summak, Baglibel, and Samancioglu (2010) updated Parasuraman's (2000) Technology Readiness Index (TRI) in Turkey to justify instructors' technology willingness. Figure 4 shows the model adapted by (Wu et al., 2008).

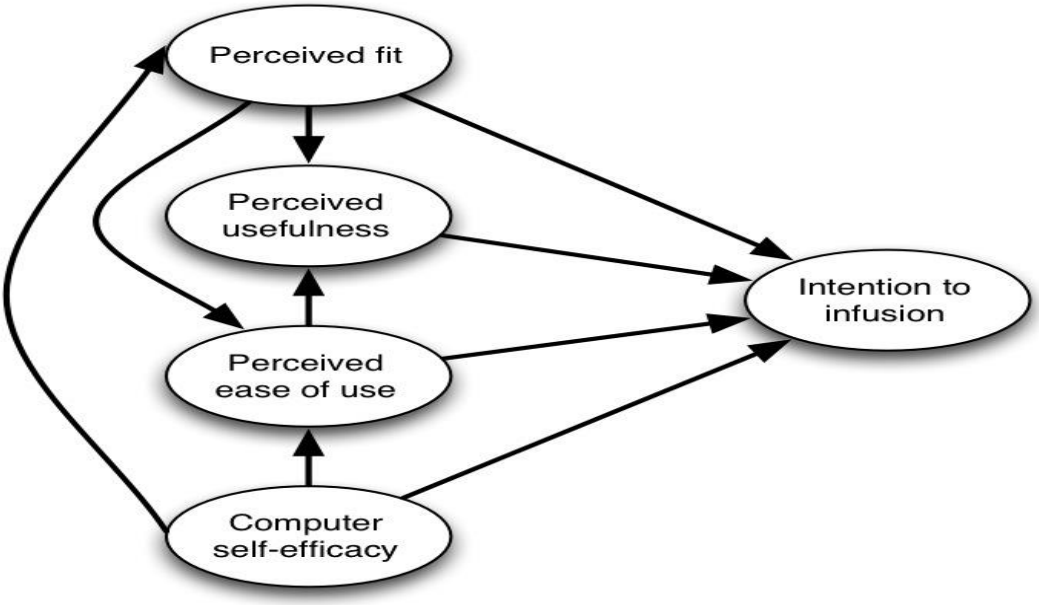

Figure 4: A model developed by Wu et al. (2008)

To assess readiness, the TRI used four criteria: optimism, innovativeness, discomfort, and insecurity. The survey sample included 207 teachers from 11 different schools. The educators' willingness, according to them, was modest. According to the data, educators' optimism outweighed their inventiveness, while their uncertainty outweighed their discomfort. These findings suggested that teachers were not technologically prepared. Summak et al (2010) concluded that the ministry of education and school administrators should provide programs to help educators improve their technological preparedness.

In Virginia, Holden and Rada (2011) expanded TAM to include perceived usability, technological self-efficacy, and computer self-efficacy. The researchers evaluated ninety-nine educators from rural schools. According to Holden and Rada (2011), the proposed model explained more variation and provided more impacts than TAM variables. Furthermore, the findings confirmed that the correlations between all variables were significant. In explaining instructors' use of technology, TAM benefited more from technology self-efficacy than computer self-efficacy. The distinction between the two parts, computer self-efficacy (Compeau & Higgins, 1995) and technological self-efficacy (Holden & Rada, 2011), was that the former assessed confidence in general computer use, whereas the latter assessed confidence in effectively employing technology. Holden and Rada (2011) concluded their study by stating that more research is needed to investigate the impact of technological self-efficacy on technology adoption by different groups and technologies. They also suggested that future research look at external barriers to understand customer concerns better and identify ways to improve the technology under consideration. Holden and Rada's model is depicted in Figure 5. (2011).

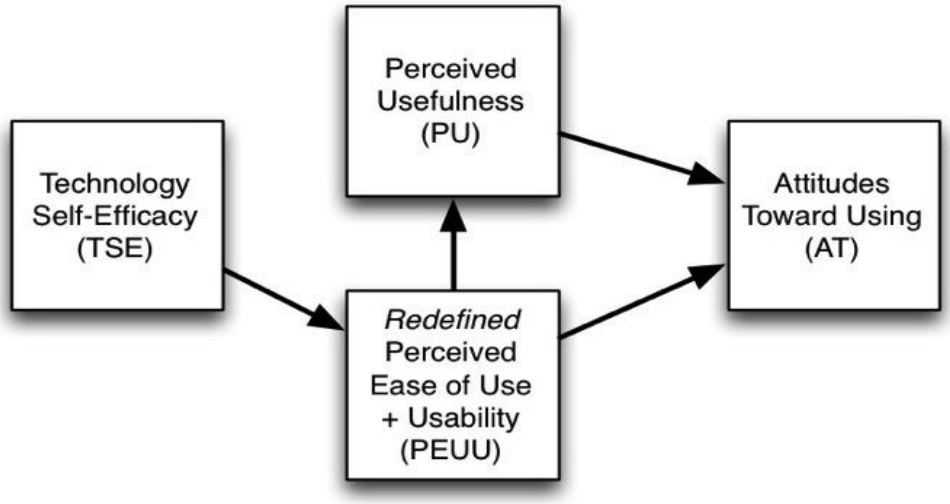

Figure 5: Adapted Technology Acceptance Model (Holden & Rada, 2011)

In Malaysia, Phua, Wong, and Abu (2012) modified TAM by including perceived enjoyment. The researchers developed the model to assess how home financial educators use the Internet. Phua et al. (2012) confirmed that the proposed model fits the data well. Furthermore, the findings revealed that most higher education professors were eager to use the Internet in the classroom. The results also confirmed that Internet attitude, perceived utility, perceived ease of use, and reported enjoyment all had significant positive associations with behavioral intention. The researchers used Pearson's r correlation to analyze their data. They recommended that future researchers use structural equation modeling to analyze the data in order to discover causal correlations between study variables (Phua et al., 2012). Figure 6 depicts Phua et al.'s modified model (2012).

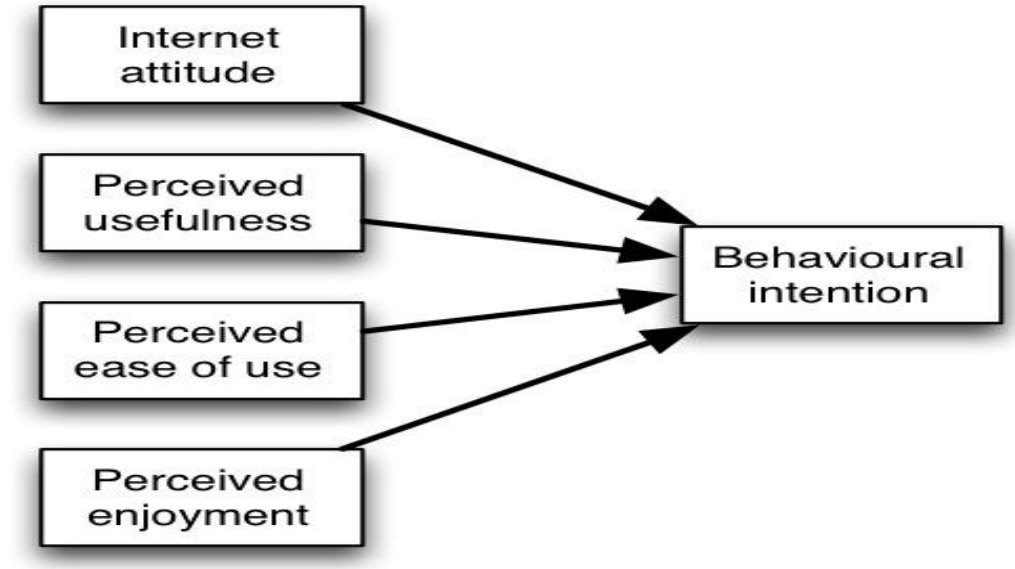

Figure 6: Modified Technology Acceptance Model (Phua et al., 2012)

Nair and Das (2012) used TAM in India to assess high school mathematics educators' technology adoption. A total of 195 instructors participated in the study and filled out a questionnaire survey. The model had much support, according to the researchers. Furthermore, the findings revealed that perceived simplicity of use influenced attitudes toward usage and perceived usefulness. On the other hand, perceived usefulness did not affect attitudes toward usage. The study's author proposed that TAM be modified to include characteristics linked to technology and topic area, which might directly or indirectly influence educators' motivation to utilize technology.

Moses, Wong, and Bakar have been doing research (2013). They identify the factors influencing math and science teachers' attitudes regarding laptop use. TAM was employed by Moses et al (2013) to predict educator acceptance of laptops. Two hundred ninety-two science academics and 278 mathematics lecturers received a survey questionnaire. The findings suggested that perceived utility influenced attitudes toward laptop use. Despite this, perceived ease of use had little effect on attitudes toward laptop use. According to Moses et al (2013), qualitative research is needed to understand better the antecedents of educators' attitudes about technology usage. Figure 7 shows the developed model by (Moses et al., 2013).

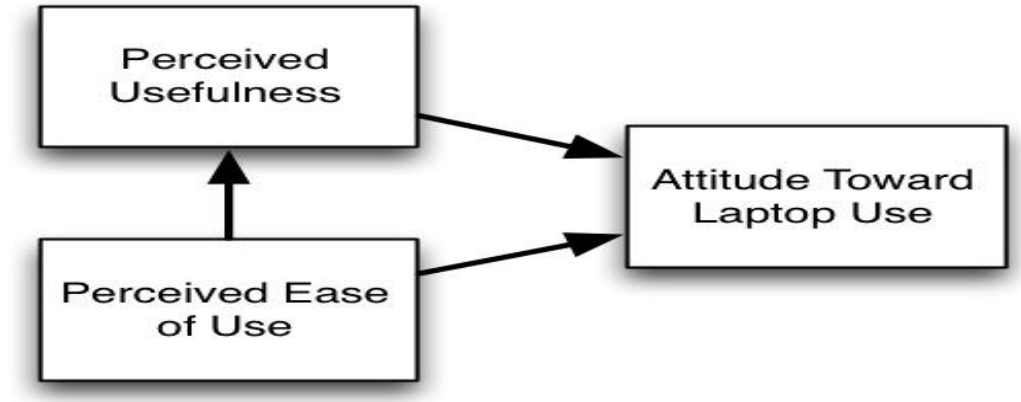

Figure 7: A model developed by Moses et al (2013)

A Review Models on Pre-Service Educators

The use and adaptation of models on pre-service instructors have also been validated through research. Chen (2010) proposed a model for examining the factors influencing pre-service educators' use of technology to improve student-centered learning in the United States. This study used a convenience sample of 206 pre-service instructors and a survey research approach. Context, training, value, efficacy, and usage were all paradigm components. Chen (2010) found that the proposed model suited the data relatively well.

Moreover, the data revealed that self-efficacy to use technology had the most significant influence on technology use. Additionally, context (assistance, time, and cost) significantly impact technology adoption. Hence, element training significantly affected element value (usefulness) and self-efficacy. However, the element value did not affect technology utilization. Chen (2010) concluded his study by recommending that future research look into the social and environmental elements influencing educators' decision-making. Figure 8 shows the model developed by Chen (2010).

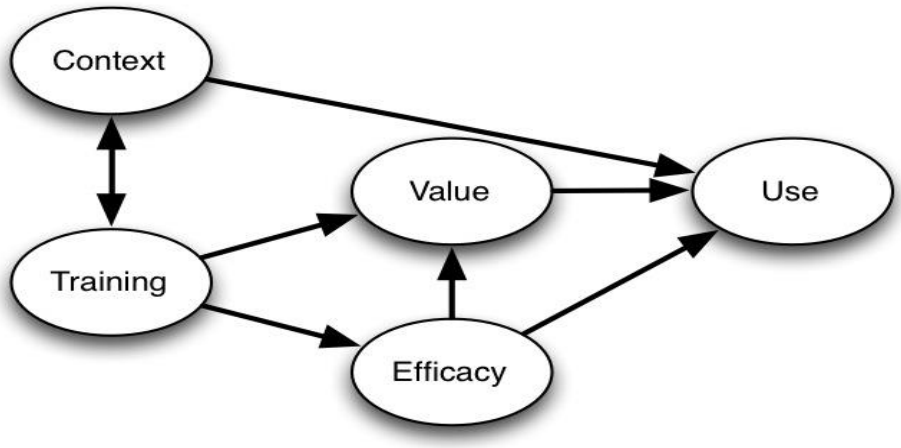

Figure 8: A Model Illustrating Pre-Service Educators' Use of Technology for Student-Centered Learning (Chen, 2010)

Teo (2010) assessed TAM's cross-cultural validity for pre-service instructors in Malaysia. This study enlisted the help of 189 pre-service teachers. They had to complete a survey questionnaire. The findings revealed elemental and factorial validity. TAMPST (Technology Adoption Model for Pre-Service Educators) was a reliable and successful model for predicting technology acceptance among pre-service educators. Furthermore, the correlations between all of the variables were significant. Finally, Teo (2010) emphasized the importance of future research into the validity and reliability of TAM for pre-service and in-service educators from different cultures.

Teo and Schaik (2012) evaluated four models: TAM, TRA, TPB, and an upgraded model, to determine which model best supports pre-service educators' intentions in incorporating technology. The researchers polled 429 pre-service educators at a Singapore educator training institute. The findings indicated that the four models were well-fitting to the data, with no significant differences in expressive power amongst them. Finally, Teo and Schaik (2012) advised that more research be conducted into influencing the intention to utilize technology. Figure 9 shows the integrated model by (Teo and Schaik, 2012).

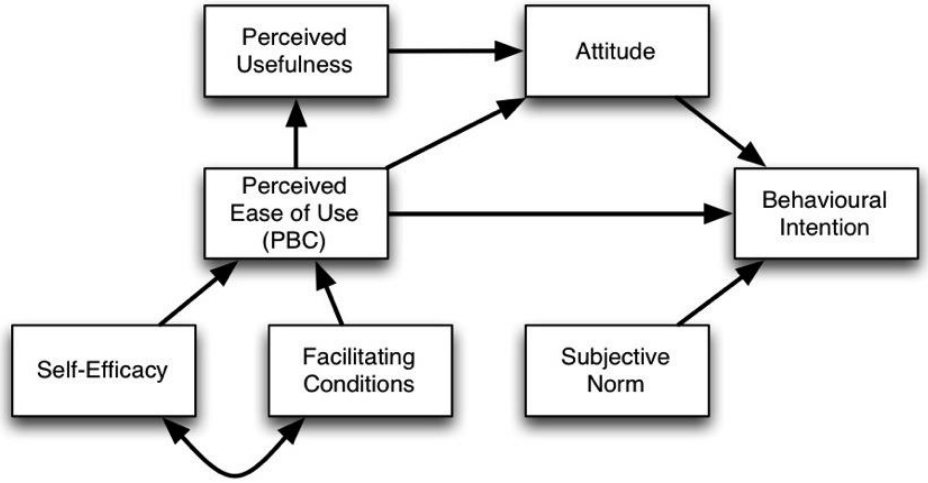

Figure 9: Integrated Model (Teo & Schaik, 2012)

Wong, Osman, and Goh (2013) conducted a study in Malaysia to assess student instructors' intentions to use technology. TAM was chosen to be evaluated to predict students' and teachers' use of technology in the classroom. A total of 322 people took part in the survey. They were handed a questionnaire to complete. According to the findings, TAM had an excellent match to the data. Furthermore, the interactions between all of the TAM components were significant. Wong et al (2013) found that a larger sample size was required to achieve a better outcome. It can improve the general well-being of the entire population.

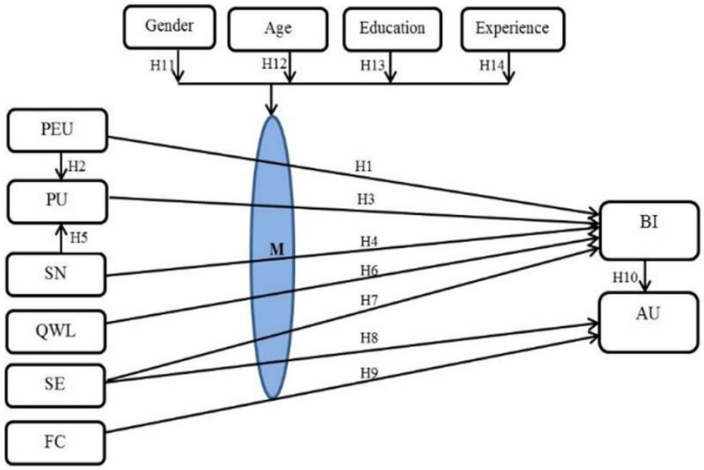

Figure 10: The Proposed Model by (Tarhini et al., 2016)

Tarhini et al (2016) aimed to develop a proposed model that explained how social, cultural, individual, and organizational factors could affect students' acceptance and the attitude towards web-based learning systems. The extended variables are quality of work-life, social norm, facilitating conditions, and self-efficacy. In addition, knowing the symbolic variables is very helpful for educators in designing meaningful activities while promoting knowledge and meaningful learning.

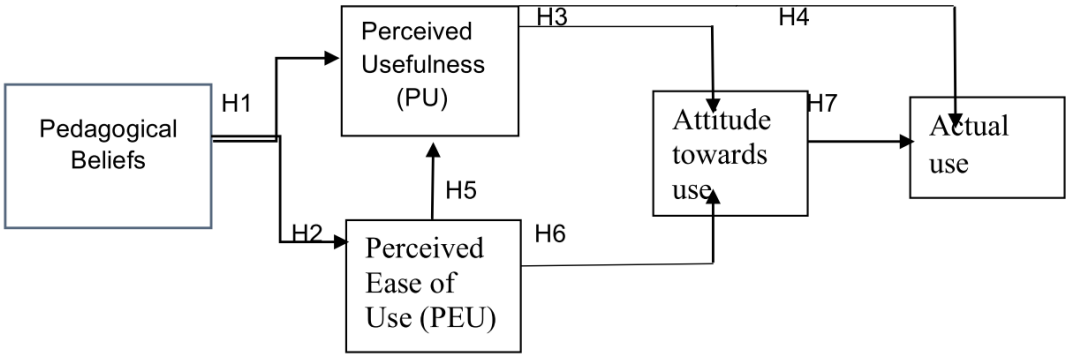

Figure 11: The Extended Model by (Gyamfi, 2016)

A study done to see a relationship with perceived ease of use and perceived ease of use e by (2016) entitled identifying Ghanaian pre-service teachers' readiness for computer use: a technology acceptance model approach found that pre-service teachers' pedagogical beliefs have a significusefulness. Both variables also have a positive attitude toward computer use and directly influence pre-service teachers' actual use of computers. Nonetheless, perceived use has no significant relationship with perceived usefulness. The findings fill the literature by validating the technology acceptance in the Ghanaian setting and adding significant implications in the research and practice of technology integration.

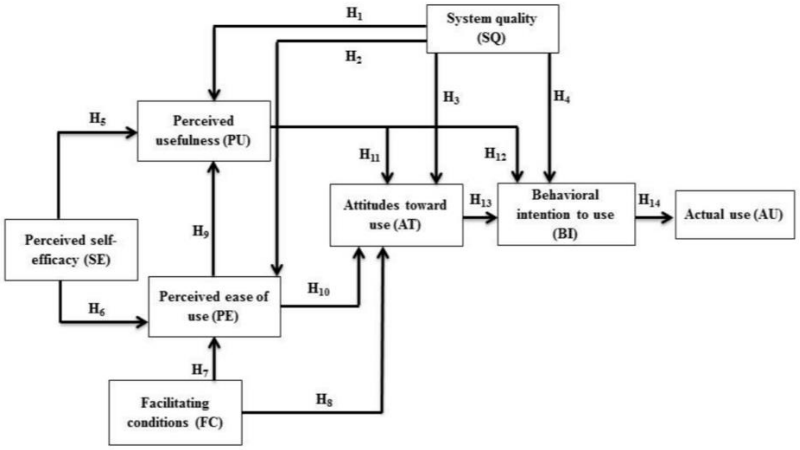

Figure 12: Extended technology acceptance model for learning management systems by (Fearnley & Amora, 2020)

An extended technology acceptance model for learning management systems by (2020) mentions that a learning management system can elevate the instruction of technology. It is an essential element of successful application in higher education. The findings show that system quality and perceived self-efficacy are strong predictors. The study also found that positive beliefs about one's ability to use the system are valuable and easy to use. This study has implications in practice, policy, and future research.

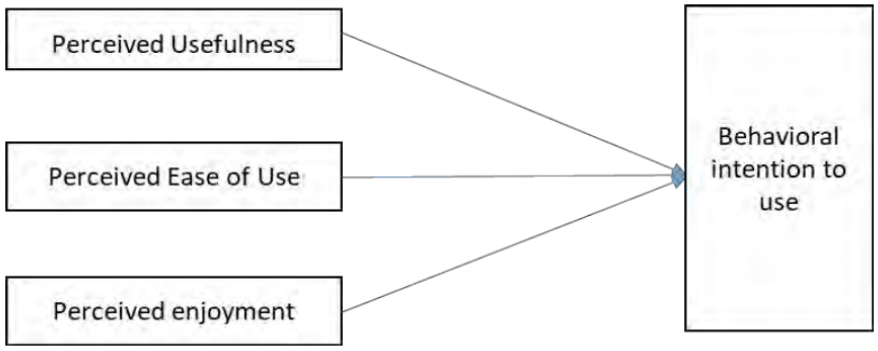

Figure 13: A Framework for Students' Acceptance of AR by (Ping & Liu, 2020)

In the past decades, the augmented reality of AR has gained popularity ever since. In their study, Field Ping and Liu (2020) found that AR is a handy tool in teaching and learning because it is grounded on the efficiency of teaching models such as constructivism. However, it is crucial to understand students' acceptance of AR. The findings show that students have a very high behavioural intention towards AR in learning. AR-based learning also promotes thinking skills and enhances cognitive processes. Overall, this study promotes three crucial aspects: the AR's usefulness towards students' real-life learning, designing the east-to-navigate AR, and finally, making the learning process enjoyable.

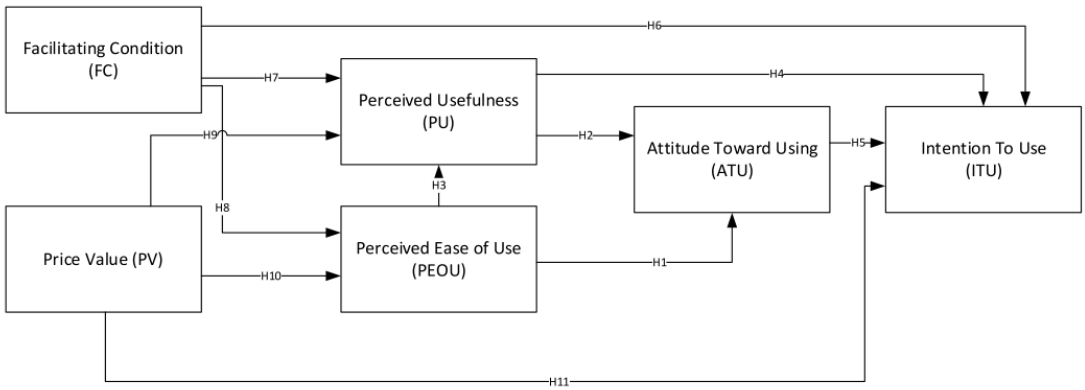

Figure 14: The Proposed Conceptual Model by (Fauzi et al., 2021)

In exploring the students' acceptance of the use of Google Classroom in Indonesia, (Fauzi et al., 2021) extended the technology acceptance model and came up with their proposed model. The finding shows that possession of required tools to use the technology, ease of use, and usefulness are the main essential variables in their extended model. Google Classroom can reach its maximum potential when it is provided adequately. The usefulness also has a significant relationship with attitude towards Google Classroom.

Discussion of Findings

Table 1. The extended variables

No	Model	Extended Variables
1.	Technology Acceptance Model (Hu et al., 2003)	Job Relevance, Compatibility, Computer Self-Efficacy & Subjective Norms.
2.	A Model Developed by Wu et al., (2008)	Perceived Fit & Computer Self-Efficacy.
3.	Proposed Model (Inan & Lowther, 2010)	Overall Support, Technical Support, Computer Availability, Computer Proficiency, & Teachers' Readiness.
4.	Pre-Service Educators' Use of Technology for Student-Centered Learning (Chen, 2010)	Context, Training, Value & Efficacy
5.	Adapted Technology Acceptance Model (Holden & Rada, 2011)	Technology Self-Efficacy
6.	Modified Technology Acceptance Model (Phua et al., 2012)	Perceived Enjoyment.
7.	Integrated Model (Teo & Schaik, 2012)	Self-Efficacy, Facilitating Conditions, Subjective Norm
8.	A Model Developed by Moses et al. (2013)	Attitude toward Laptop Use
9.	The Proposed Model by (Tarhini et al., 2016)	Quality of Work Life, Social Norm
10.	The Extended Model by (Gyamfi, 2016)	Pedagogical Beliefs
11.	Extended technology acceptance model for learning management systems by (Fearnley & Amora, 2020)	System Quality, Actual Use
12.	A Framework for Students' Acceptance of AR by (Ping & Liu, 2020)	Perceived Enjoyment
13.	The Propose Conceptual Model by (Fauzi et al., 2021)	Price Value

Table 1 shows the extended variables from eight different studies that adapted Technology Acceptance Model into newly modified ones. The most frequent variable used by the eight researchers is self-efficacy (including computer self-efficacy, technology self-efficacy, and efficacy). The second one is facilitating conditions (including training, computer availability, overall and technical support). The others are subjective norms, teachers' readiness, perceived fit, perceived enjoyment, context, and value. As for the past five years, more research on technology acceptance models has been done, and more extended models can be found looking at the different perspectives. The extended variables are the quality of

work-life, social norm, pedagogical beliefs, system quality, actual use, perceived enjoyment, and price value.

The findings of various extended variables show that Technology Acceptance Model is a versatile model that can be adopted and adapted regardless of the sample, population, or field. It can be adapted as long as the main focus of the study is to look for any technology acceptance towards a new technological-based approach or pedagogies or acceptance towards the existing ones.

Conclusion

These studies of technology-enhanced learning show that developing unique models is a good idea. TAM is applicable to be adopted or adapted in various situations, as evidenced by its ability to assess instructors' adoption of a specific technology, as demonstrated in the preceding review. Moreover, all of the research has used only one method: a survey questionnaire. Additionally, most of these studies indicated that new factors should be included in TAM to assess their significance in predicting educators' technology adoption.

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