

Technology Acceptance Models used on online learning: A review.

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Abstract

The concept of the e-learning system has become a crucial part of the education process, whether elementary, secondary, or higher education, but it still faces different acceptance problems. The students are still resistant to engaging in online learning. They don't use communication, interaction, and collaborative tools, and the percentage of applying digital collaborative learning is decreasing, especially in developing countries. The primary goal of this study is to review different acceptance technology models and understand their factors to help educational institutions select the best model suitable to their environments. It also helps the researchers extend them accordingly.

Keywords: *Technology acceptance; TAM; UTAUT*

I. INTRODUCTION

Technology and internet development changed teaching and learning methods. These evolvments improve education quality [1]. The E-learning system has facilitated the teaching and learning deliverance process, particularly for individuals who cannot attend universities. Through promoting the education process and development, the concept of the e-learning system has become a crucial part of the education process, whether elementary, secondary, or higher education. According to [2], Digital learning resources include various tools and applications that increase student learning and make teaching more efficient. Covid-19 forced many educational institutions to adopt E-learning systems [3]. After the pandemic, educational institutions gradually changed regulations to increase the E-learning portion compared with traditional teaching. That comes after understanding the benefits of technology in enhancing the educational process and reducing education expenses, especially in developing countries. However, students' engagement in online learning is not as effective as face-to-face learning [4]. Students do not use communication, interaction, and collaborative tools, especially in synchronous online learning. Many research uses and different models exist to solve such problems and evaluate the intention and actual use of communication, interaction, and collaborative tools in online learning [5]. No ideal model is

suitable for all environments; this research will introduce the most popular models used in the learning field and explain their factors to help different organizations select the suitable model.

II. THEORETICAL REVIEW

A. ELearning

[6] ELearning is the use of information technology to implement learning strategies and contents. [7] ELearning is using the internet to support the learning process in educational institutions. [8] Nowadays, many universities adopt computer software like Learning Management Systems (Blackboard, Moodle, and Microsoft Teams) in their teaching programs. [9] After the appearance of the COVID-19 pandemic, specifically in March 2020, many educational institutions were forced to switch to the ELearning system to overcome the Lockdown problem. However, many challenges were raised, such as the technological infrastructure inside and outside the schools, the skills of instructors and students to deal with this new technology, and the adoption or acceptance of the instructors and students to use the technology. Therefore, after 2020, we will see many research studies about ELearning, developing new models and strategies to integrate traditional learning with technology. That makes it essential to assess the students' adoption of ELearning systems. This will help establish new learning software to enhance student engagement and increase their interaction with the class content.

B. Adoption of information systems:

The information system adoption models introduced in the 1980s, each model consists of a group of attributes that affect user technology adoption. One of the most common models is the Technology Acceptance Model (TAM) [10]. According to TAM, two factors affect consumers' acceptance of technology. First, how useful is technology in improving their work? (Perceived usefulness). Second, how is it easy to use the technology? (Perceived ease of use). After that, Venkatesh and Davis proposed TAM2 (Extended TAM) [11]. TAM2 includes the same factors as TAM and other factors related to behavioral intention and information technology [12]. Venkatesh et al. [13] proposed the Unified Theory of Acceptance and Use of Technology (UTAUT). It integrated eight technology acceptance models. It is based on TAM and other factors related

to Motivation, behavior, PC utilization, Innovation, and social cognition. Venkatesh et al. (2012) [14] Proposed UTAUT2; it enhanced UTAUT by including Hedonic, Price Value, and Habit. After that, Farooq(2017) [15] introduced the UTAUT3 model specific to E-Learning acceptance. It is extended from previous theories such as UTAUT2, the theory of reasoned action, the theory of planned behavior, and TAM.

III. ACCEPTANCE TECHNOLOGY MODELS

A. Original version of TAM

TAM was proposed to provide a software maker with a methodology to evaluate their newly developed computer-based system before implementing or deploying it in the new environment [10]. TAM addressed the main factors influencing user acceptance of any newly proposed computer system. As shown in Fig. 1, the TAM model proposed that Perceived Usefulness (PU) and Perceived Ease of Use (PEU) are the most influential factors in technology acceptance by computer users. Perceived usefulness assumes that the computer system will increase work quality and productivity. Whereas perceived ease of use assumes that the user uses less effort to do the work, which will make him enjoy the work and give him more time to accomplish another task [16]. PU and PEU affect the user's Attitude toward Using the Technology (ATUT). Increasing PU or PEU will positively impact the user ATUT. The TAM is conducted using a questionnaire that includes questions for PU and PEU factors, where the Likert-like scale is used to measure the acceptance score for each question.

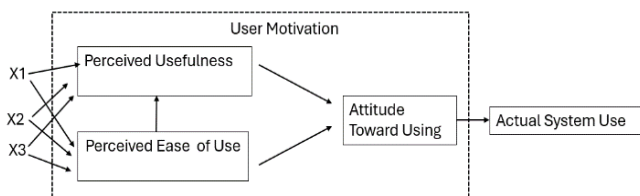


Figure. 1: Original version of TAM ([10])

B. The First Modification of TAM

In 1989, Davis used TAM to understand computer usage behavior, as shown in Fig. 2. Davis' (1989) TAM aims to explain the determinants of computer acceptance. The essential TAM model components are Perceived Usefulness (PU) and Perceived Ease of Use (PEU). PU and PEU influence the Attitude Toward Using (ATU) factor. PU and ATU influence the Behavioral Intention to Use (BIU) factor. Other elements, known as external variables in TAM, can affect a person's belief system regarding the evaluated system

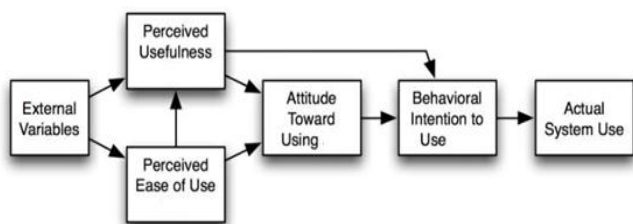


Figure. 2. TAM after the first modification [17].

C. The Second Modification of TAM

Venkatesh and Davis (1996) [18] developed the final iteration of the TAM after discovering that PU and PEU directly impact behavior intention, which in turn removed the Attitude Toward the Using factor, as shown in Fig. 3.

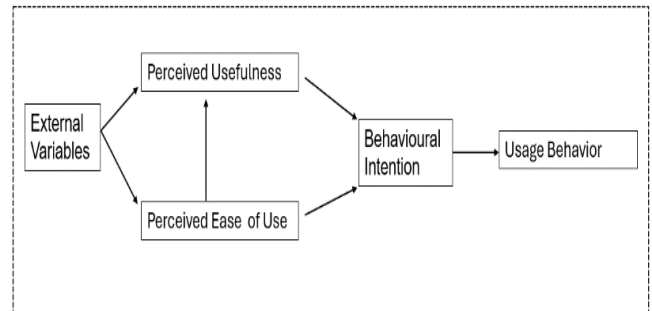


Figure. 3. AM after the second modification [18].

D. Technology Acceptance Model 2 (TAM2):

(Venkatesh and Davis, 2000) [11] Proposed a new model called TAM2 through an extended TAM model, which is based on PU and PEU. TAM2 adds two theoretical constructs to the TAM model. First, social influence includes subjective norms, images, and voluntariness. Second, cognitive instruments include four factors: result demonstrability, perceived ease of use, output quality, and job relevance. According to TAM2, the two structs will determine whether the user will accept or reject the newly proposed computer system. The architecture of TAM2 is shown in Fig. 4.

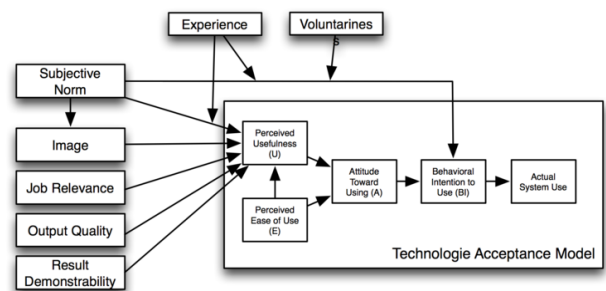


Figure. 4. Technology Acceptance Model 2 (TAM 2) [11]

E. Technology Acceptance Model 3 (TAM3)

Venkatesh and Bala (2008) [19] proposed TAM3 by combining TAM2 with the model of the determinants of Perceived Ease of Use (PEU), as shown in Fig. 5. The authors introduce the TAM3 using the four different types, consisting of the individual differences, system characteristics, social influence, and facilitating conditions which are determinants of PU and PEU. TAM3 found that experiences moderated the relationship between PEU and PU, computer anxiety and PEU, and PU and behavioral intention. Natural computer-based systems were used to evaluate the model.

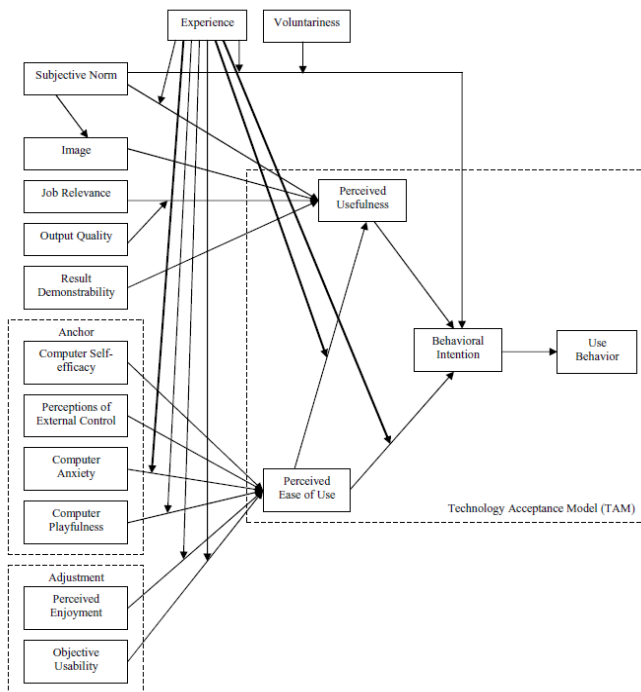


Figure 5. Technology Acceptance Model 3 (TAM3) [21].

Ibrahim et al. [20] modified the TAM model to measure the accuracy of the e-learning system in higher education. The proposed model includes six constructs: PU, PEU, Intention to Use (IU), instructor characteristics, efficiency of the computer system, and the design of the course. They reported that computer efficiency significantly influences the perceived ease of use factor. The ease-of-use factor significantly influenced users' intention to use the ELearning system. The study was conducted on a group of undergraduate students in Malaysia.

Al-Azawei et al. [21] extended the TAM model with learning styles, e-learning self-efficacy, and perceived satisfaction to study the acceptance of a blended learning system based on one ELearning and traditional learning system among undergraduate students. The study showed that learning styles do not affect perceived usefulness, intention to use, or satisfaction.

Liu et al. [22] Added four new variables to the TAM model: Perceived Interaction online, User-interface Design, Course Design, and Previous Online Learning Experience. The study conducted on students who study English language in Taiwan. The study found that the design of the user interface significantly influences the perceived ease of use factor. The design of online courses is the most influential factor in perceived usefulness and perceived user interaction.

Almaiah et al. (2016) [23] built a model to assess the acceptance of Mobile learning among university students. The proposed model is based on DeLone, McLean and TAM models. The study conducted at five public universities in Jordan. The study shows that the user's intention to use online learning is influenced by content quality, design quality, User interface quality, Responsiveness, Interaction, Personalization, Functionality, and Accessibility.

Fathema et al.[24] modified TAM to analyze the external variables that affect the acceptance of the learning management system (LMS) among faculty staff in two USA universities. The study concludes the system's quality, self-efficacy, and facilitating conditions. These variables significantly influence the PU, PEU, and BIU factors and the user attitude using the LMS.

Mohammadi [25] the use of e-learning, is influenced by two constructs: User Satisfaction (US) and Intention to Use (IU). Six external variables affect the US and IU mainly: the quality of education, quality of service, quality of technical system, quality of content, PU, and PEU. The study applied to four universities in Tehran and concluded that the system's quality significantly influenced the US and IU constructs.

Mailizar et al. [26] extended TAM by proposing a new model to assess mathematics teachers' acceptance of online teaching. The model includes five constructs: IU, PU, PEU, Attitude Toward Using, and Experience. The study found that users' prior experience in ELearning usage significantly influenced PU and PEU. The study was implemented in a group of mathematics teachers in Indonesia.

Tawafak et al. [27] combined TAM with another model called Expectation Confirmation Theory (ECT) to assess the acceptance of the ELearning system by undergraduate students in Oman. According to the study, PU and PEU accurately predict students' approval of the ELearning system. The student behavioral intention (BI) significantly influenced the actual use of ELearning. The model comprises six components: PU, PEU, BI, Support Assessment (SA), and Student Satisfaction (SS).

Almaiah et al. [28] Modified TAM to measure the acceptance of mobile learning by undergraduate students in Saudi Arabia. Four external factors were used, namely PU, PEU Technological Infrastructure (TI), Support of Management (SM), Culture (CL) and Awareness (AW). The results showed that TI, SM, and AW significantly influenced the acceptance of mobile learning.

Al-Adwan et al. [29] Extended TAM to assess the student acceptance of metaverse technology in education. PU, PEU Personal Innovativeness (PI), and Perceived Enjoyment (PRE), Perceived Cyber Risk (PCR). The study found that PU, PI, and PE significantly influence the acceptance of metaverse technology in education. At the same time, PEU had no significant influence. PCR was found to be the inhibitor to adopting the metaverse in education.

Alshurideh et al. [30] used TAM to study the students' intention to adopt the ELearning system. It's based mainly on three constructs: PU, PEU, and perceived enjoyment (PRE). Five external variables were used mainly: simulation, role plays, flipped classrooms, games, and problem-based learning. The study showed that all external variables significantly affect students' intention to use ELearning.

Table 1 provides a summary of the primary studies that implemented a modified TAM model during the period 2010-2023. The selected studies were chosen based on their citation on the Google Scholar website.

TABLE 1 NUMBER OF SELECTED TAM STUDIES IN E-LEARNING (2010-2023)

Reference	Year	Methods	Targeted group	Country	citations
[25]	2015	Modified TAM: based on constructs User Satisfaction (US) and Intention to Use (IU). Six external variables influence the US and IU mainly: the quality of education, quality of service, quality of technical system, quality of content, PU, and PEU.	390 undergraduate students	Iran	991
[22]	2010	Modified TAM: Perceived Interaction online, User-interface Design, Course Design, Previous Online Learning Experience.	436 senior high school students	Taiwan	979
[24]	2015	Modified TAM: based on external variables, the quality of the system, self-efficacy, and facilitating conditions.	560 faculty members	USA	897
[21]	2017	Modified TAM: based on learning styles, self-efficacy, and perceived satisfaction.	210 undergraduate students	Iraq	315
[23]	2016	Modified TAM: based on the perceived interaction, the design of the course, the design of the user interface, and the user's previous experience.	400 undergraduate students	Jordan	262
[20]	2017	Modified TAM: PU, PEU, Intention to Use (IU), instructor characteristics, efficiency of the computer system, and the design of the course.	95 undergraduate students	Malaysia	191
[21]	2021	Modified TAM: The model includes five constructs: IU, PU, PEU, Attitude Toward Using, and Experience.	161 math teachers	Indonesia	112
[27]	2023	Modified TAM: The model consists of six components: PU, PEU, BI, Support assessment (SA), and Student Satisfaction(SS).	220 undergraduate students	Oman	9
[28]	2022	Modified TAM: PU, PEU Technological Infrastructure (TI), Support of Management(SM), Multure (CL), and Awareness (AW).	600 undergraduate students	Saudi Arabia	56
[29]	2023	Modified TAM: PU, PEU Personal Innovativeness (PI), and Perceived Enjoyment (PRE), Perceived Cyber Risk (PCR)	574 undergraduate students	Jordan	47
[30]	2023	Three constructs mainly: PU, PEU, and Modified TAM: perceived enjoyment (PRE). Five external variables were used mainly: simulation, role plays, flipped classrooms, games, and problem-based learning.	532 undergraduate students	Jordan	8

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

Venkatesh et al. (2003) [13] examined existing models and proposed an integrated UTAUT model, as shown in Fig. 6. In the UTAUT model, the user intention to use technology is measured using four strcuts derived from eight previous models. UTAUT structures include facilitation conditions, social influence, effort, and performance expectancy. According to the UTAUT, these four user factors directly affect and moderate all or part of the four constructs: age, gender, experience, and voluntariness of use.

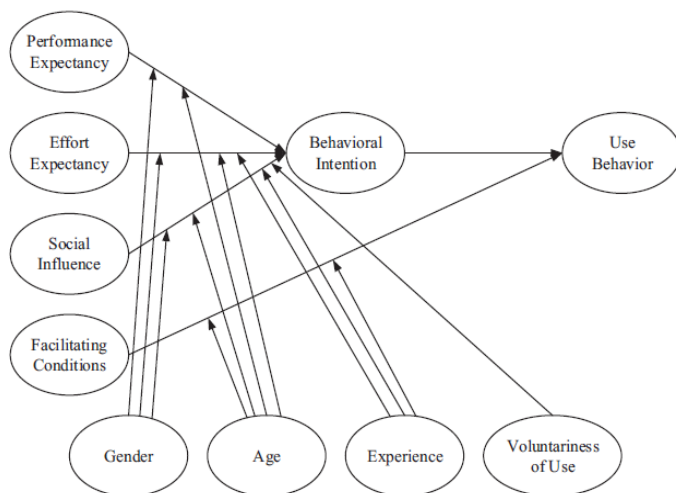


Figure. 6. Unified Theory of Acceptance and Use of Technology (UTAUT) [13]

Performance Expectancy (PE)

Performance expectancy is based on the TAM idea of perceived usefulness (PU), which in turns affect work performance [31]. It expresses a person's or user's belief that using a specific IT-supported product or service would help them improve their performance. Scholars have combined it with four moderators influencing behavioral intention and observed use behavior: gender, age, voluntary usage, and experience. Previous research shows that consumers who are convinced of the advantages of technology will be more willing to accept it.

Effort Expectancy (EE)

The effort expectancy of UTAUT fits into TAM's perceived ease of use constructs which shows that users prefer using a particular system that requires less effort to handle.

Facilitating Conditions (FC)

In general, if a product has the benefit of providing technical and management support, the confidence level in its actual use will be increased. These facilitating factors increase the actual system use among users of a system [32]. Facilitating Conditions (FC) is defined as a situation where users of the technology believe that there is sufficient managerial and technical support available for the use of a particular technology [13]. As a result, when consumers believe that administrative and technical assistance is available for technology, they accept its use [19].

Behavioral Intention to use (BI)

According to the theory of reasoned action (TRA) [33] there is

robust connectivity between BI and actual behavior, the intent of an individual's behavior is the most crucial factor; if the person's intention is strong enough, the behavior will occur. The essential principles and illustrative models of technology acceptance, such as TAM1, TAM2 (Venkatesh and Davis, 2000), or UTAUT (Morris et al., 2003), claimed the intention to use a new technology act as a primary factor for the actual use of technology.

G. UTAUT2

According to Venkatesh (2012) [14], the UTAUT2 was proposed to assess technology adoption in a new environment. UTAUT2 combines three more factors with the UTUT model: Habit (HT), Price Value (PV), and Hedonic motivation (HM), as shown in Fig. 7. UTAUT2 adopted three demographic characteristics (experience, age, and gender) from the UTAUT model and eliminated voluntariness of use attribute. These demographic characteristics or variables directly influence the Behavioral Intention (BI) of the users to adopt the new technology; the newly added structs in UTAUT2 yielded a significant increase in BI compared to UTAUT [14].

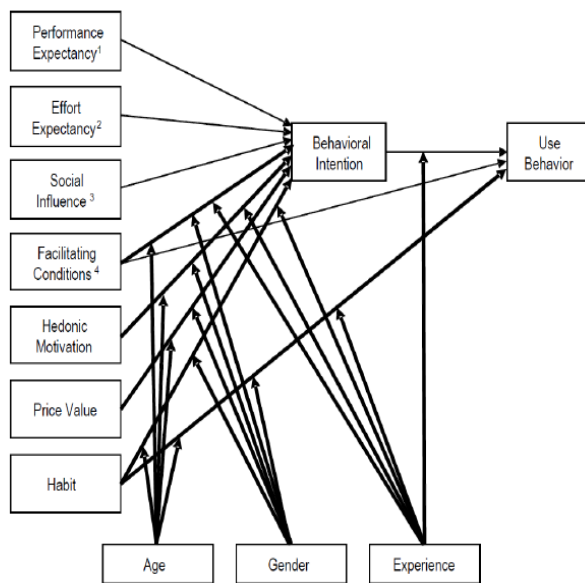


Figure 7. UTAUT2 [14]

Hedonic Motivation (HM)

HM is the intrinsic incentive to use technology, such as enjoyment, fun, or delight. It is a crucial notion in technology adoption and use. HM is performed in TAM as intrinsic motivation (IM) [14][34].

Price Value (PV)

People often choose items or services whose PV is matched by their benefits. As a result, the application's profits and price should be balanced. In an E-learning system, the model is free, and this factor will not be a concern in this study.

Habit (HT)

HT is a powerful predictor of technology adoption. The degree to which people are prone to use something regularly is referred to as a habit [14] [34].

H. UTAUT3

The UTAUT3 framework by Farooq et al. (2017) [15] was introduced as an extension to the UTAUT2 model. As shown in Fig 8. eight determinants of technology acceptance were used: mainly: performance expectancy (PE), Effort expectancy (EE), social influence (SI), facilitating influence (FC), hedonic motivation (HM), price value (PV), Habit (HT), and Personal Innovativeness (PI) which was added as the eighth factor. The model consists of a new variable PI and all UTAUT/UTAUT predictors. Compared with UTAUT2, UTAUT3 removed the three demographic characteristics (experience, age, and gender) and replaced them with Personal innovativeness. Personal innovativeness in IT significantly influences understanding the adoption of education technology. In UTAUT3, the eight factors PE, EE, SI, FC, HM, PV, HT, and PI influence the user's BI. Whereas users' behavior (UB) is controlled by BI, PI, FC, and HT.

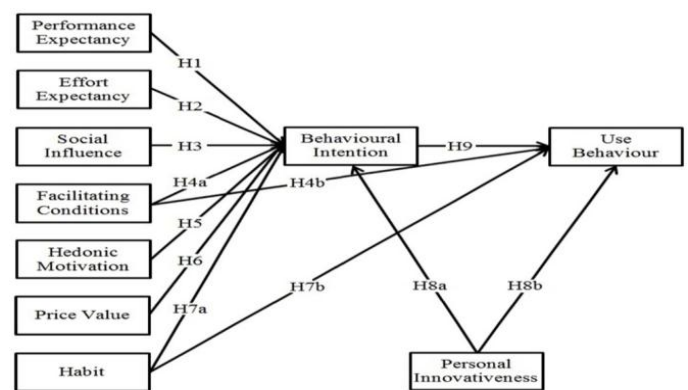


Figure 8 UTAUT3 (Farooq et al., 2017)

Chao [35] Studied the factors that influence students' Behavioral Intention to accept mobile Learning systems in universities. It extended the UTAUT model by adding five constructs: risk moderators (RM), self-efficacy (SE), trust (TS), perceived enjoyment (PRE), and satisfaction (SA). The study found that the most influential factors in mobile learning are SA, PRE, TS, and effort expectancy, respectively, according to their influence.

Salloum et al. [45] used UTAUT to assess the acceptance of the ELearning system by undergraduate students in the United Arab Emirates. Four factors (PE, EE, SI, and FC) from UTAUT were used in the experiment. The study concluded that FC, PE, and PE directly influenced users' behavioral intention to adopt the ELearning system.

Alshehri et al [36] extended UTAUT by adding six external variables and assessing their role in user behavioral intention to use LMS in Saudi Arabian higher education institutes. The variables are as follows: assessment, interactivity, system design learnability, and quality of information navigation of the system. The study found that the quality of information and system interactivity influence the PE factor. Where assessment instructions, system navigation, and learnability control the EE factor.

Abbad [37] studied the users' acceptance of ELearning Moodle among university students. The study is based on the UTAUT

model. Four constructs were used mainly: PE, EE, SI, and FC. The study found that PE and EE significantly influenced BI, whereas SI did not affect the BI factor. BI and FC significantly affect Moodle usage.

Šumak et al. [38] studied the influence of different UTAUT constructs on the acceptance of the use of Moodle LMS among undergraduate students. Four constructs (PE, EE, SI, FC) were used to assess users' Attitudes toward using (ATU) and Behavioral intention (BI). The study found that students at ATU are significantly affected by PE and SI, whereas SI and ATU strongly determined user BI to use Moodle. User BI greatly determines the student's use of the Moodle system.

Almaiah et al. (2019) [39] Studied the effect of different factors of the UTAUT model on mobile learning acceptance among undergraduate students. Seven external variables were investigated: trust, Compatibility, awareness, security, information quality, resource availability, and system efficacy. The results showed that all the factors affect the user's acceptance of mobile learning.

Gunasinghe et al. [40] UTAUT was used to measure the adoption of ELearning among undergraduate students in Sri Lanka. Seven constructs were used. The study found that PE, EE, FC, HT, and HM positively impacted ELearning adoption. SI and PI did not influence ELearning adoption.

Ahmed et al. [41] extended UTAUT with perceived enjoyment (PRE), mobile self-efficacy (MSE), social isolation (SI), and

Fear of COVID-19 (FCD) to assess the adoption of online learning during the COVID-19 pandemic. SE, EE, FC, PE SI, PRE, and MSE significantly influence users' BI using ELearning systems. However, PRE does not affect BI.

Raman et al. [42] The authors applied the UTAUT Model to a group of postgraduate students. The group of students were studying in the same class on Moodle LMS. The study showed that gender moderately affects EE, PE, FC, and SI. Additionally, gender does not strongly influence users BI to accept ELearning.

Hunde et al [43] Five constructs of the UTAUT model were used to assess users' intention to adopt ELearning, mainly performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitation condition (FC), and perceived enjoyment (PRE). It was found that EE and PRE significantly influenced users' BI. FC had a direct influence on users' acceptance of ELearning. PE did not affect users BI to accept ELearning.

Tewari et al. [44] Modified UTAUT to extend it with perceived security (PS). The results showed that PE, EE, SI, FC, and PS had a significant impact on students' use of ELearning during the third wave of COVID-19 in India.

Table 2 summarizes the main studies that implemented the modified UTAUT model during the period 2010-2023. The selected studies were chosen based on their citation on the Google Scholar website.

Table 2 Number of selected UTAUT studies in E-learning (2010-2023)

Reference	Year	Methods	Targeted group	Country	citations
[35]	2019	Modified UTAUT: Adding five constructs mainly: risk moderators (RM), self-efficacy (SE), trust (TS), perceived enjoyment (PRE), and satisfaction (SA).	1562 undergraduate students	Taiwan	898
[45]	2019	Modified UTAUT: Four factors from UTAUT (PE, EE, SI, FC)	280 undergraduate students	United Arab Emirate	173
[36]	2020	Modified UTAUT: Used external variables: assessment, interactivity, system design learnability, quality of information navigation of the system.	605 undergraduate students	Saudi Arabia	24
[37]	2021	Modified UTAUT: Four external variables were used mainly: PE, EE, SI, and FC.	370 undergraduate students	Jordan	247
[38]	2010	Modified UTAUT: Four constructs (PE, EE, SI, FC) and their influence on ATU and BI	354 undergraduate students	Slovenia	300
[39]	2019	Modified UTAUT: Seven external variables were investigated: trust, Compatibility, awareness, security, information quality, resource availability, and system efficacy.	697 undergraduate students	Saudi Arabia	275
[40]	2020	UTAUT: Seven external variables were used mainly: PE, EE, FC, HT, HM, SI and PI	441 undergraduate students	Sri Lankan	181
[41]	2022	Modified UTAUT: extended UTAUT with perceived enjoyment (PRE), mobile self-efficacy (MSE), social isolation (SI), and Fear of COVID-19 (FCD)	1875 undergraduate students	Malaysia, Bangladesh, South Korea, Pakistan, and India	43
[42]	2014	UTAUT: four external variables were used mainly: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitation condition (FC). Studied how gender influences them.	65 postgraduate students	Malaysia	147
[43]	2023	UTAUT: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitation condition (FC), and perceived enjoyment (PRE).	637 undergraduate students	Ethiopia	21
[44]	2023	Modified UTATU: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitation condition (FC), perceived security (PS)	424 undergraduate students	India	11

CONCLUSION

This paper reviews the main models used to evaluate the adoption of ELearning systems. TAM and UTATU models and their evolution over the last three decades were reviewed. The main modifications and extended versions of TAM and UTAUT were also explained. Each model states different factors and studies their influence on the adoption of ELearning among students. Based on the previous models, the intention to use technology is determined by human, environmental, and technology quality factors.

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