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A SYSTEMATIC REVIEW OF THE UTAUT AND UTAUT2 AMONG K-12 EDUCATORS

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ABSTRACT

Aim/Purpose	The purpose of this systematic literature review is to evaluate the application of UTAUT and UTAUT2 frameworks in K-12 education.
Background	This study included an analysis of peer-reviewed empirical studies that use the UTAUT and UTAUT2 frameworks to understand the factors that influence technology adoption among K-12 educators. New constructs were identified, and core determinates of the models were studied.
Methodology	The researchers used a systematic literature review. Inclusion criteria required articles to be written in English, non-duplicate, peer-reviewed, focused on K-12 educators, and employing quantitative methods to test or extend the UTAUT or UTAUT2 models. We used a strategic search string to conduct standardized searches across multiple databases in education, psychology, business, engineering, and multi-disciplinary publications. We conducted a screening process on the initially identified 98 articles. We kept 14 articles for final analysis, as they met the inclusion criteria.
Contribution	This study contributes to the fields of (a) information science, (b) information technology (IT), and (c) education by offering a more detailed analysis and understanding of the use of UTAUT and UTAUT2 in studying technology adoption among K-12 educators.
Findings	The results show performance expectancy and social influence are the core factors most commonly used. We identified and organized a total of 27 new variables into a taxonomy. We identified discrepancies in the application of the models and further discussed them. The use of UTAUT and UTAUT2 in K-12 education is minimal.

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Recommendations for Practitioners	Findings inform stakeholders in education (e.g., directors of technology operations, administrators, educators) and educational technology businesses (e.g., software engineers, interface and content designers, and user experience designers) how to create and integrate products that fit the true needs of the end-users. Technology must align with the tasks needed to accomplish educational objectives (performance expectancy), and certain environmental conditions are needed to support technology usage. Educators should also be aware their decisions regarding technology adoption are influenced by social factors, such as their superiors and peers.
Recommendations for Researchers	Researchers need to conduct more studies using UTAUT and UTAUT2 within K-12 education. It is likely that teachers are influenced by their students, although little research exists to study this relationship through the lens of these models. Moreover, consideration should be given when renaming variables, using certain relationships, and developing research models.
Impact on Society	Findings support our understanding of educational technology adoption, which benefits our education system, especially teachers and students alike, when done successfully.
Future Research	Future research should include a meta-analysis exploring the statistical extent of relationships and new variables identified.
Keywords	education, UTAUT, UTAUT2, technology adoption, K-12, educators

INTRODUCTION

Technology impacts the way educators design, deliver, and manage education. Increasing choices include innovative software, multimedia, and processing capabilities that make the education technology landscape appealing yet extensive. Research within education about technology adoption commonly focuses on factors that influence end users, such as teachers and students, across different grade levels, theoretical models, and types of technology (Granić, 2022; Scherer et al., 2020). Teacher's digital literacy plays a critical role in technology adoption (Wohlfart & Wagner, 2023). Research has shown that a teacher's attitude, beliefs, self-efficacy, and experiences with educational technology influence their technology adoption (Dindar et al., 2021; Hermans et al., 2008; Sang et al., 2010; van Braak et al., 2004).

Exploring technology adoption in education often begins with the application of theoretical frameworks that provide a structured lens for understanding the complex processes involved. Among these frameworks, the Technology Acceptance Model (TAM) (Davis, 1989) is frequently utilized in education (Granić & Marangunić, 2019; Imtiaz & Maarop, 2014) given its robust and strong predictive capabilities (King & He, 2006). The TAM is also considered a core model, meaning it has served as the basis for new model development (Scherer & Teo, 2019). Yet, the TAM is not without limitations, including a lack of moderators, simplicity, and the use of self-reports to measure future behavior (Gangwar et al., 2014; Lim, 2018).

Given the prevalent use of TAM in the education field, the researchers of this study choose to explore the application of the unified theory of acceptance and use of technology (UTAUT) and its extension (UTAUT2) (Venkatesh et al., 2003) among educators specifically in kindergarten through twelfth grade (K-12). In contrast to TAM, the utilization of UTAUT and UTAUT2 in K-12 education remains less investigated despite the extensive body of research employing these models in business, management, and technology domains (Dwivedi et al., 2019, 2020; Tamilmani et al., 2021). For instance, in a systematic review, Venkatesh et al. (2016) observed only one instance of applying

UTAUT in K-12. Similarly, in another review, 4 of 39 articles applied UTAUT or its extensions in K-12 education (Yee & Abdullah, 2021). At best, these models are frequently used at the university or higher education levels (Khechine et al., 2016).

Problem Statement

Despite the numerous publications that exist about the UTAUT, it is minimally used to understand technology adoption among teachers in K-12 education. This is problematic for several reasons. First, it hinders the generalizability of the models, thus potentially minimizing their utility and application in new settings (i.e., K-12 education). Second, it hinders a deeper understanding of the technology adoption phenomenon in K-12 educational settings, therefore affecting collective knowledge and practical applications in education. Last, the limited body of research literature that applies the UTAUT frameworks in K-12 grade levels presents a challenge for conducting meta-analyses and systematic reviews due to the limited availability of data to comprehensively assess constructs and relationships within these contexts. Despite the limited body of research, the authors were still motivated to investigate papers about technology adoption in K-12 education through a UTAUT lens. A comprehensive review of the UTAUT and UTAUT2 models in grades K-12 is currently lacking in the research literature.

Purpose

The purpose of this systematic literature review is to better understand the phenomenon of technology adoption among K-12 educators. This study includes an analysis of peer-reviewed, empirical studies that use the UTAUT and UTAUT2 frameworks to understand factors that influence technology adoption, especially new constructs added to the models. In addition, this review includes the identification of the most frequently used original UTAUT and UTAUT2 factors and their outcomes. Understanding the extent to which the new and original constructs work in these settings provides an opportunity to build on existing knowledge and explore new areas.

Research Questions

The current systematic literature review answers two primary research questions:

1. What are the new variables that researchers have added to the UTAUT or UTAUT2 models to measure behavioral intention or use among K-12 educators?
2. Which original UTAUT and UTAUT2 independent variables (i.e., ease of use, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit) are the most frequently used and significant predictors of technology adoption among K-12 educators?

Literature Review

Technology Adoption in Education

Various technology acceptance models exist to explain educator and student adoption behaviors. Some examples include the Concerns-Based Adoption Model (CBAM) (G. E. Hall, 1979), which is a qualitative change management tool that facilitates discussions about concerns from teachers during a transition; the Technology Acceptance Model (TAM) (Davis, 1989); and the Unified Theory of Acceptance and Use of Technology Model (UTAUT) (Venkatesh et al., 2003). Each of these frameworks has its respective benefits, trade-offs, and recommended applications within the education domain (Straub, 2009). The General Extended Technology Acceptance Model for E-learning (GETAMEL) has gained popularity for its specific focus on studying e-learning (Abdullah & Ward, 2016). Although focused on technology integration, the Technological, Pedagogical Content Knowledge model (TPACK) has also equipped educators to make informed decisions about how to use technology to enhance teaching and learning (Mishra & Koehler, 2006). Frameworks like the TAM and UTAUT demonstrate robust psychometric properties across various contexts, users, countries, and

time (Sharma & Mishra, 2014; Taherdoost, 2018), and to date, they continue to be the two most frequently used models to understand technology adoption in education (Abuhassna et al., 2023) (see Table 1 for a summary of selected models).

Technology adoption frameworks have been used to study many facets of the field of education; for instance, student adoption (VanDerSchaaf et al., 2021) and educator adoption (Tseng et al., 2019), including pre-service teachers (Teo & Noyes, 2014). In addition, technology adoption frameworks have been used to compare preferences for educational technology types (Oyetade et al., 2020; Sprenger & Schwaninger, 2021) and to evaluate or integrate with other theoretical models (Buabeng-Andoh & Baah, 2020; Ranellucci et al., 2020). Researchers investigating this topic are called to consider systematic ways to evaluate the effectiveness of the technologies being adopted (Lai & Bower, 2019) and to strengthen efforts to increase the quality of methodological and procedural reporting (Tamim et al., 2021).

Table 1. Sample of technology adoption frameworks used in education

Framework	Main constructs and concepts	Brief definitions
CBAM (G. E. Hall, 1979)	Use Concern	How likely the innovation will be used. Feelings of concern about the technology.
TAM (Davis, 1989)	Usefulness Ease of Use Attitude	Perception that the innovation will improve performance. Perception that the technology is easy to use. Personal attitude towards using the technology.
UTAUT (Venkatesh et al., 2003)	Performance Expectancy Effort Expectancy Social Influence Facilitating Conditions	Perception that the innovation will improve performance. Perception that the technology is easy to use. The impact important others have on use. The availability of resources and support to use the technology.
GETAMEL (Abdullah & Ward, 2016)	Usefulness Ease of Use Attitude Computer Self-Efficacy Subjective Norms Anxiety Enjoyment Experience Behavioral Intention to Use	The perceived benefit of e-learning technology. Perception that the technology is easy to use. Attitude towards using e-learning technology. Belief in one's ability to use a computer. Social norms and influences on e-learning use. Fear and anxiousness about, or during, tech use. Enjoyment while using technology. Skills gained from using the technology over time. Intent on using e-learning technology for educational purposes.
TPACK (Mishra & Koehler, 2006)	Technological Knowledge Pedagogical Knowledge Content Knowledge	Knowledge of technologies used to teach. Knowledge of teaching and learning. Knowledge of the subject being taught.

Factors That Influence Educator's Technology Adoption

Individual characteristics

Well-known areas of technology acceptance in K-12 education include how self-beliefs, attitudes, and motivations of teachers affect their intention to use technology. When teachers have a positive attitude towards technology (Teo, 2011), it enhances the perceived usefulness of it to increase their productivity, which in turn, raises the likelihood of its adoption. Various factors, including a teacher's

intrinsic value, utility value, perceived instrumentality, social responsibility, and social concern, also significantly contribute to their acceptance and use (Nelson, 2011). A systematic review found that teachers' pedagogical beliefs related not only to their technology use but also increased the time spent in technology-rich learning environments, which fostered a greater potential to shift pedagogical beliefs towards student-centered approaches (Tondeur et al., 2017).

Institutional factors

Institutional factors also play a crucial role in technology adoption. Consequently, the presence of educational technology in a classroom does not translate into technology acceptance for a variety of reasons. Infrastructure (e.g., correct servers, wiring, power, physical space) plays a critical role. For example, despite having "high tech" classrooms, Cuban et al. (2001) found several infrastructure barriers to utilization, and most notably, the technology only upheld existing teaching practices instead of transforming their design or delivery. Besides having the right conditions for technology adoption, educators need time. Educators need time to choose the right software for their curriculum and develop learning plans that use the technology in a transformative, student-centered way (Francom, 2020). Adequate time for professional development about educational technology, a supportive culture (Teo et al., 2009), and a commitment to sustainable program-wide systems of professional learning (U.S. Department of Education, 2017) can influence technology acceptance and use. A. B. Hall and Trespalacios (2019) found that when teachers can personalize their professional development programs by customizing the content, specifying their learning needs, and setting their own goals, there is a higher likelihood of significant increases in their technology skills and self-efficacy. Similarly, teachers showing early adopter characteristics and dedicating substantial amounts of time to integrating educational technology into their classrooms are more likely to overcome its complexity and adopt it (Aldunate & Nussbaum, 2013). The administration impacts technology adoption, too. For instance, technology leadership in schools (Anderson & Dexter, 2000) and having a well-defined purpose for adopting educational technology have been found to significantly affect technology adoption (Porter & Graham, 2016).

Technical design

The features of technology itself affect technology adoption. A frequently studied feature of technology includes its usefulness, as seen in TAM (Davis, 1989). Meta-analysis shows the usefulness of technology in supporting teaching and student learning is the biggest contributor to technology acceptance (Scherer & Teo, 2019). Researchers have also examined the playfulness of technology. Playfulness, described as a person perceiving an interaction with the system as fun and enjoyable, had a significant impact on student intentions to adopt technology (de Oliveira Neto et al., 2023). In females, playfulness directly affects attitude, and among males, playfulness mediates the relationship between attitude and intention to use the technology (Padilla-Meléndez et al., 2013). The security and privacy of technology significantly influence students' attitudes, which significantly influences their behavioral intention and usage (Arpaci et al., 2015). Other factors such as interactivity, control, reliability, and user tools also significantly predict the intention to use e-learning tools among students (Martínez-Torres et al., 2008). Similarly, Bere and Rambe (2016) found that a range of factors, including device portability, communication cost, collaborative capabilities, and learner control, influence the adoption of mobile instant messaging in university learning.

Review of the UTAUT Models

The UTAUT model was developed by Venkatesh et al. (2003) to originally predict employee behaviors within an organization. Later, researchers described the UTAUT model as one of the most robust, reliable, and comprehensive technology adoption models in the information science and technology literature (Khechine et al., 2016). The model has four primary constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) and four primary moderator variables (gender, age, experience, and voluntariness). The constructs influence an individual's behavioral intention, which then influences technology use behavior (see Figure 1). At the time of the

UTAUT's development, many technology adoption theories and frameworks existed. The development of the UTAUT involved testing 18 constructs from eight prominent technology adoption models, including (a) the theory of reasoned action (Fishbein & Ajzen, 1977), (b) the theory of planned behavior (Ajzen, 1991), (c) the combined-technology acceptance model and theory of planned behavior (TAM-TPB; Taylor & Todd, 1995), (d) the motivational model (Davis et al., 1992), the innovation of diffusion theory (Rogers, 2003), (f) the social cognitive theory (Bandura, 1986; Compeau & Higgins, 1995), (g) the technology acceptance model (Davis, 1989), and (h) the model of PC utilization (Thompson et al., 1991). The UTAUT explained about 70% of the variance in individual technology adoption (Venkatesh et al., 2012). However, in a recent meta-analysis, the UTAUT model underperformed in educational contexts; it only attained an R^2 of 47.2% (Or, 2023).

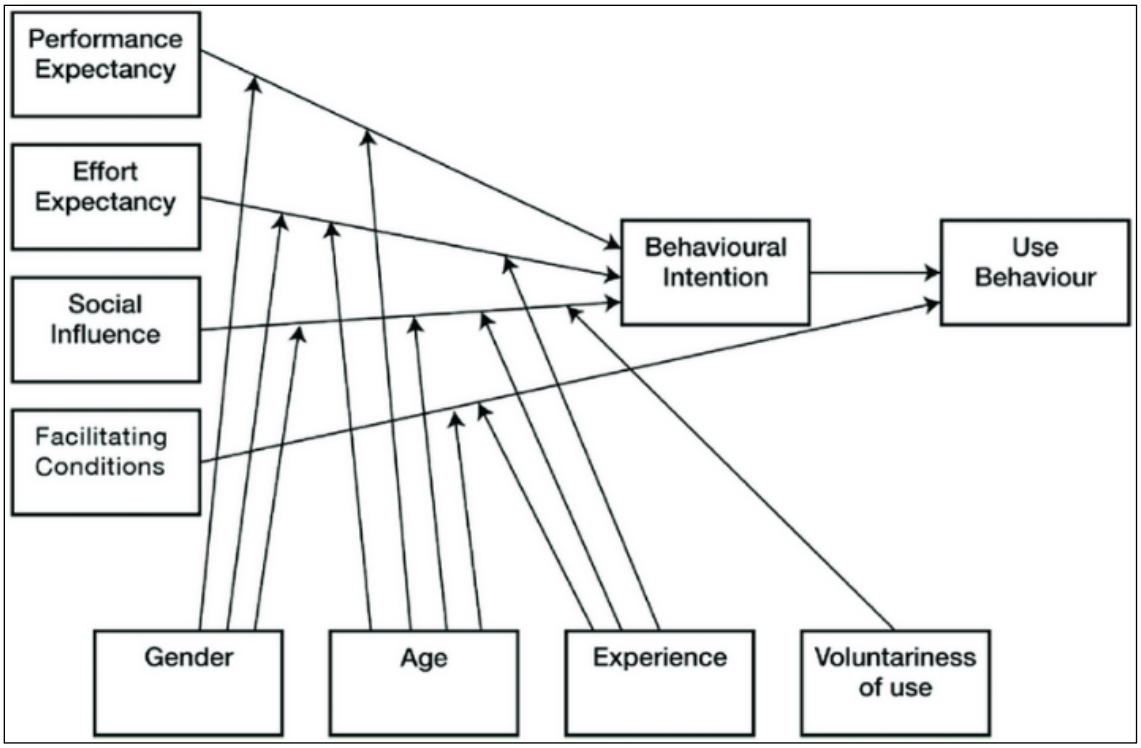

Figure 1. The UTAUT model (Venkatesh et al., 2003, used with permission)

In later developments, the UTAUT2 explained technology adoption among consumers (Venkatesh et al., 2012) (see Figure 2). UTAUT2 included three new primary constructs: (a) *hedonic motivation*, defined as fun or pleasure gained from using the technology; (b) *price value*, defined as the cost of buying the technology; and (c) *habit*, defined as a learned, automatic behavior (Venkatesh et al., 2012). One of the original primary moderators, the *voluntariness of use*, was omitted from UTAUT2, given that most consumer behaviors are voluntary and not mandated by an organization. The inability to yield acceptable amounts of variance led to the researchers dropping the voluntariness of use from UTAUT2.

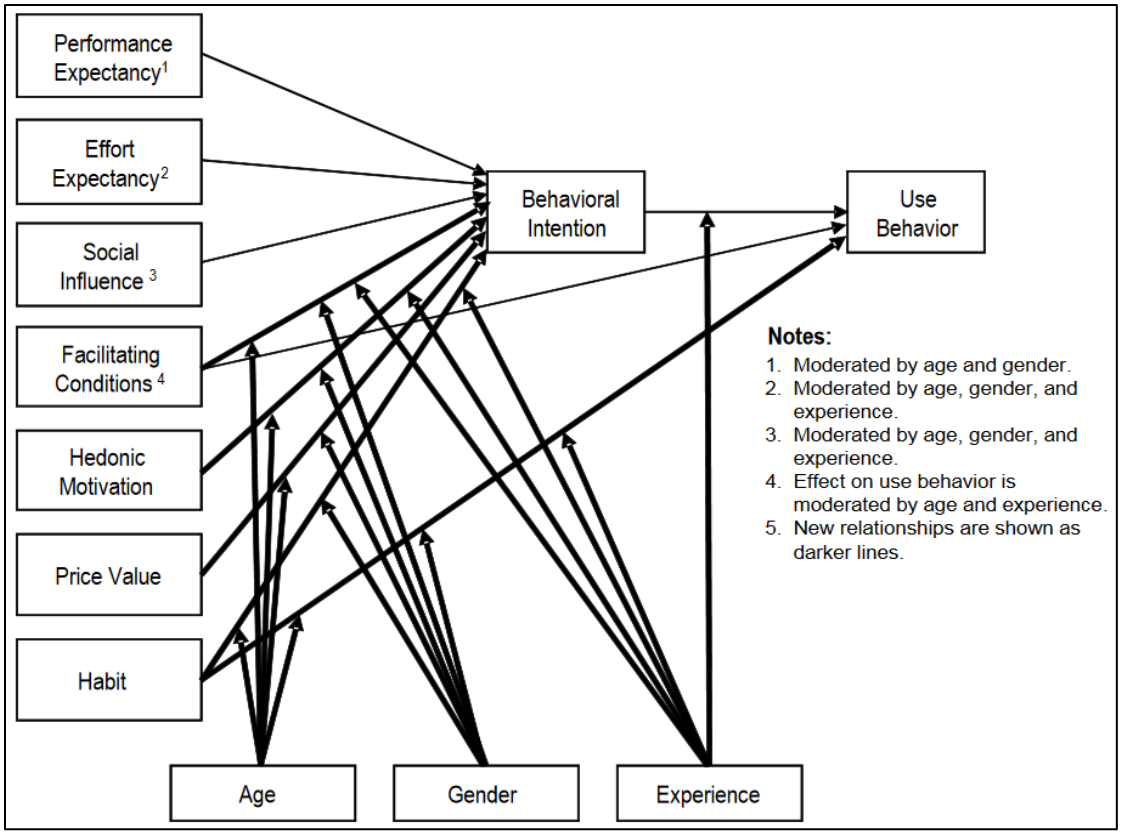

Figure 2. The UTAUT2 Model (Venkatesh et al., 2012, used with permission)

METHODS

The following sections provide details on the methods used to conduct, synthesize, and draw conclusions from the articles used in this systematic literature review. In general, seven procedural steps were taken. First, research questions were developed. Second, inclusion and exclusion criteria were aligned with the research questions. Third, a search strategy was devised, incorporating specific databases and a customized search string uniformly applied across the selected databases. Fourth, a staged review was conducted involving the examination of abstracts and titles, resulting in the exclusion of duplicates or articles failing to meet the inclusion criteria. Fifth, a preliminary number of records were kept, forming the basis for forward and backward searches. Sixth, a thorough screening of the articles was conducted, involving the data extraction and documentation of relevant metadata (see the Appendix). Finally, the data gathered underwent synthesis and tabulation. The relationships between variables were tabulated for frequency, and their outcomes, such as "significant positive result" or "significant negative result," were documented. Newly identified variables were systematically organized into a taxonomy with accompanying frequency counts.

According to methodology and organizing guidance from Callahan (2010) and Torraco (2005), systematic reviews should (a) outline where the literature was found, (b) provide the start and end dates when the review was conducted, (c) explain who conducted the searches (e.g., individuals and teams), (d) share how the literature was located (e.g., the use of search terms and their combinations), (e) identify how many articles were found versus used in the study (e.g., total results for each search versus for final analysis), and (f) why articles were kept or eliminated from the study (e.g., inclusion and exclusion criteria). A flow chart adapted by PRISMA (Moher et al., 2009) provides an organized way to track the inclusion and exclusion of articles. In sum, the measures outlined in this section support the interpretation of the results and conclusions of the study.

Inclusion and Exclusion Criteria

Articles had to meet specific inclusion and exclusion criteria to be included in this systematic review. Articles had to adhere to the following criteria: (a) written in English, (b) be a non-duplicate study (i.e., records reusing the same population and data, but published across different journals are excluded), (c) be published in a peer-reviewed journal (i.e., exclusions included studies published in proceedings or reports and dissertations), (d) focus on technology adoption for educational purposes (i.e., studies occurring in a business context are excluded), (e) use teachers in a K-12 setting as the primary research subjects (i.e., studies that used students or that took place in higher education for data collection are excluded), (f) be quantitative and empirical (i.e., qualitative and conceptual papers are excluded, (g) statistics that measured the structural model needed to be present to determine which factors were significant or not), (h) the dependent variable had to focus on the prediction of technology adoption or acceptance (i.e., studies using dependent variables other than behavioural intention or use behavior are excluded), (i) provide high quality data presentation such that statistical outputs could be verified, and (j) focus on testing or extending the UTAUT or UTAUT2 model(s) (i.e., studies that used UTAUT to develop their own model are excluded). Searches were not limited by time range in the past (all years were included), but the end date stopped on February 18, 2022, when the search was completed.

Databases Used

This systematic literature review utilized articles collected by searching across the following databases: (a) EBSCOhost (seven databases: Academic Search Complete, APA PsycArticles, APA PsychInfo, Applied Science & Technology Source, Business Source Complete, Education Research Complete; and Library, Information Science & Technology Abstracts); (b) ProQuest (35 databases), included among the 35 databases were American Periodicals, British Periodicals, Digital National Security Archive, Education Resources Information Center (ERIC), Library & Information Science Abstracts (LISA); (c) IEEE Xplore; and (d) Web of Science Core Collection.

Keywords and Searches

The keywords used in this systematic review were various combinations of the following words and wildcards (noted as an asterisk): "professional learning," "professional development," "preservice teacher," "teacher," "K-12," "K12," "elementary," "kindergarten," "primary school," "high school," "middle school," "junior high," "secondary school," "UTAUT*," "unified theory of acceptance and use of technology." The search string entered in the databases was: ("preservice teacher" OR "teacher" OR "professional development" OR "professional learning" OR "elementary" OR "K-12" OR "12" OR "kindergarten" OR "primary school" OR "high school" OR "middle school" OR "junior high" OR "secondary school") AND (UTAUT* "R "unified theory of acceptance and use of technology") (see Table 2 for a complete listing of database searches, filters, and initial results).

Table 2. Identification of records via database searches

Database	Filters	Field	Results
EBSCOhost	Peer-reviewed journals Full text	Abstracts	23
ProQuest	Peer-reviewed journals Full text Scholarly journals	Abstracts	13
IEEE Xplore	Journals	Abstracts	5
Web of Science	Articles	Abstracts	57

Screening Process and Study Sample

We found 98 articles via database searches. We removed 28 articles for duplication, leaving 70 articles for the next stage of processing. Next, a cursory screening (e.g., scanning titles and abstracts) ensured that articles met the inclusion criteria. A total of 60 records were removed for not meeting the inclusion criteria, leaving 10 for the next stage of processing. We conducted a forward and backward search of the 10 articles (forward - to scan articles that cite the record; backward - to scan the references of each record). The forward and backward searches resulted in four new articles. Subsequently, we used 14 articles for the analysis.

There were six primary reasons for removing 60 articles. A lack of focus on teacher technology acceptance (i.e., data was gathered from students, not teachers) was the primary reason for removing articles (k = 20). The second reason for removing articles (k = 12) was for not taking place in K-12 education (university settings were excluded). The third reason for removing articles (k = 11) was for lack of focus on the UTAUT or UTAUT2 (articles were excluded if the goal of the study was to develop a new model based on the UTUAT, or the outcome variable was not about adoption or acceptance). For a complete breakdown of the screening process and the rationales behind the ultimate exclusions, consult Figure 3.

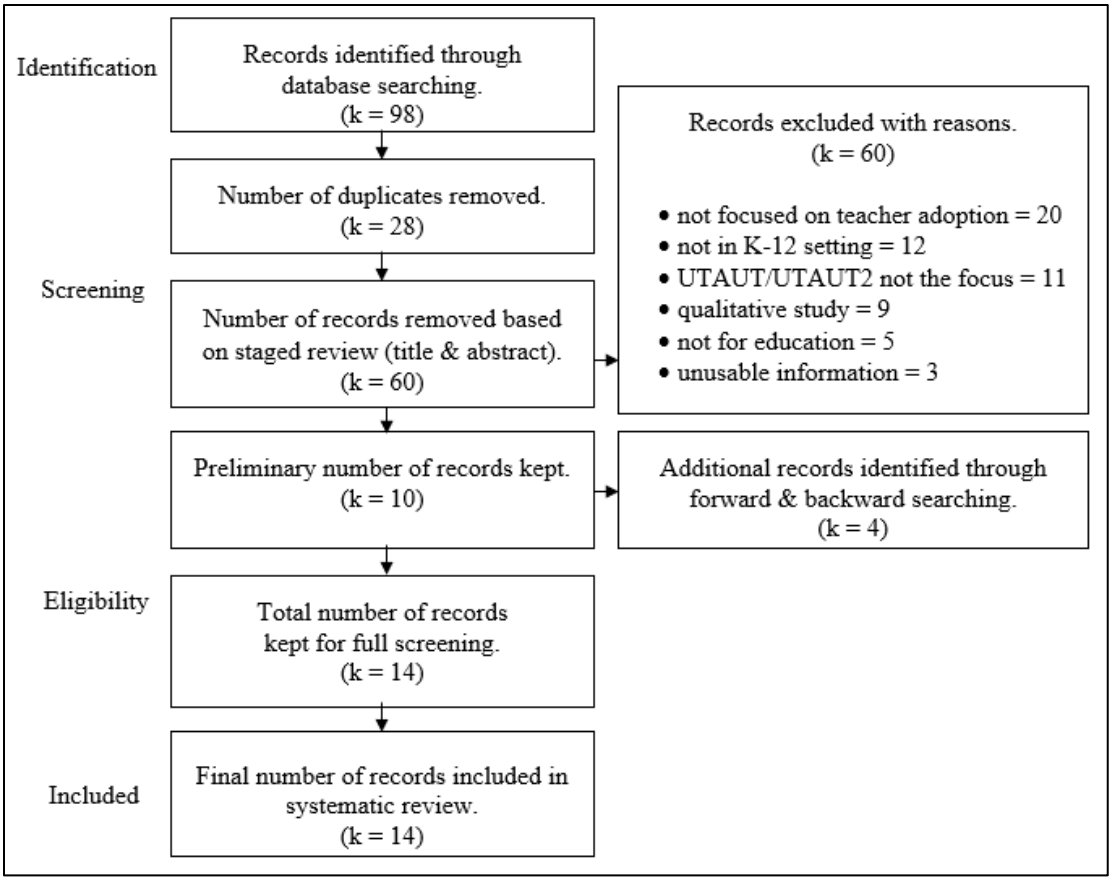

Figure 3. Screening process adapted from PRISMA (Moher et al., 2009)

Data Coding

This systematic literature review included the extraction of specific data to answer the research questions. Articles were reviewed and coded for the following items: (a) journal, (b) year, (c) author, (d) title (e) publication year, (f) country, (g) sample size, (h) school level (e.g., primary, secondary), (i)

type of technology, (j) model used (UTAUT, UTAUT2), (k) independent variables, (l) moderators, and (m) relationship effects (i.e., not significant, significant, dropped from research model, or not applicable). Please refer to the Appendix for a detailed explanation of each item. We extracted the construct names and definitions from each article.

ANALYSIS

We organized new variables into a taxonomy developed by Kemp et al. (2019). The taxonomy has seven broad, intermediate, and narrow groupings of factors that influence educational technology adoption. However, for this study, we only used the broad categories from the taxonomy, considering the limited number of new variables observed in our study. The seven broad categories to describe the factors influencing a person's use of educational technology are:

1. **Attitude, affect, and motivation.** Attitude and affect are defined as "a person's attitude towards using the educational technology and their associated affectual state" (Kemp et al., 2019, p. 2400). Motivation is the drive to learn and achieve learning tasks.
2. **Social factors.** Social factors are defined as the "perceptions of other's opinions on the use of the educational technology, including agreements and how one is perceived by others" (Kemp et al., 2019, p. 2400).
3. **Usefulness and visibility**. Usefulness and visibility are defined as "the value of using the educational technology in terms of meeting an operational need and the visibility to others" (Kemp et al., 2019, p. 2400).
4. **Instructional attributes**. Instructional attributes include the instructional design factors and the educator's characteristics, such as the technological and pedagogical content knowledge they possess (Kemp et al., 2019)
5. **Perceived behavioral control**. Perceived behavioral control is defined as the perception of one's capability and the effort required to perform a given behavior. This category includes environmental and situational factors defined as the "systemic or situational factors that affect the ability to use the educational technology" (Kemp et al., 2019, p. 2400).
6. **Cognitive engagement.** Cognitive engagement can be described as the learner's state of deep involvement, flow, and concentration in a given activity (Kemp et al., 2019).
7. **System attributes.** System attributes are the technical and functional characteristics of the system's performance, such as security, privacy, response to user inputs, and system personalization (Kemp et al., 2019).

RESULTS

This section includes findings from the systematic literature review of the usage of the UTAUT and UTAUT2 models in K-12 education. The two research questions are presented along with their respective findings.

> **RQ1:** What are the new variables that researchers have added to the UTAUT or UTAUT2 models to measure behavioral intention or use among K-12 educators?

We found 27 new variables added to the UTAUT and UTAUT2 models. This included three new moderators and one new mediator. The 27 new variables were organized into seven main categories (Kemp et al., 2019). Among the seven categories, most new variables (11) were classified under the category of *perceived behavioral control*. The second category with the most variables (7) was *attitude, affect, and motivation*. Lastly, the category with the third most variables (5) was *instructional attributes*. We did not find new variables belonging to the social factors category. There were six articles with no new variables that impacted behavioral intention or use (Ho et al., 2013; Mtebe et al., 2016; Omar et al.,

2019; Raman et al., 2014; Raman & Rathakrishnan, 2018; Tosuntaş et al., 2015). Table 3 presents the 27 new constructs and their respective definitions.

Table 3. New variables introduced into UTAUT and UTAUT2 within K-12 education

Category and counts	Author	Construct	Definition summaries
Perceived Behavioral Control (11)	Dahri et al. (2021)	Reward	Incentives provided at the end of activities to enhance engagement and outcomes.
		Support	Ongoing support for teachers to improve skills and knowledge.
	Dindar et al. (2021)	Classroom management self-efficacy	Ability to manage students and maintain discipline in an online class.
		Instructional strategies self-efficacy	The ability to use a variety of assessment methods within an online class.
		Learning management system self-efficacy	A positive belief in one's ability to use the LMS on their own.
		Online teaching self-efficacy	Proficiency in navigating the technical aspects for creating online courses.
		Student engagement self-efficacy	The ability to motivate students to show interest in online schoolwork.
	Jevsikova et al. (2021)	Pedagogical experience (moderator)	Teaching experience at the primary school level.
	Kim and Lee (2020)	Education policy	Policies about ICT-based teaching and professional development in classrooms.
		ICT usage habit	Teacher's prior ICT experiences.
	Šumak and Šorgo (2016)	Teaching experience (moderator)	The amount of teaching experience a teacher possesses.
Attitude, Affect, and Motivation (7)	Dahri et al. (2021)	Self-management	The learner's ability to exercise self-discipline and learn independently.
	Jevsikova et al. (2021)	Pandemic anxiety (moderator)	Perceived changes in anxiety during COVID-19.
		Technology anxiety	Negative emotional response to technology.
		Trust	Confidence in system service reliability and trustworthiness.
	Lopez-Perez et al. (2019)	Innovativeness	A propensity for tech innovation, experimentation, and leadership.
	Pynoo et al. (2011)	Attitude	A teacher's general impression of the digital learning environment.
	Šumak and Šorgo (2016)	Attitude (mediator)	Positive feelings linked to Interactive Whiteboards (IWBs) usage.

Category and counts	Author	Construct	Definition summaries
Instructional Attributes (5)	Dahri et al. (2021)	Collaborative learning	Collaborative online or in-person interactions among a group to achieve a goal.
		Interactivity with peers, guide teachers, institute experts	Interactions supporting learning among students, teachers, and technology experts.
	Reychav et al. (2016)	Student-to-teacher knowledge share	Student-initiated interactions with the teacher via the iPad.
		Teacher-to-student knowledge share	Teacher-initiated interactions with students via the iPad.
		Teacher-to-teacher knowledge share	Teacher-initiated interactions with other teachers via the iPad.
Cognitive Engagement (2)	Dahri et al. (2021)	Engagement	Passion for education and its impact on academic performance and behavior.
	Jevsikova et al. (2021)	Work engagement	A positive work-related state characterized by vigor and dedication.
Usefulness and Visibility (2)	Dahri et al. (2021)	Content and information quality	Digitized, correct, and relevant educational content for mobile learning.
		Knowledge acquisition	The process of obtaining and creating new information.
System Attributes (1)	Dahri et al. (2021)	Mobility	Mobile device use is unrestricted to time or location.
Social Factors (0)			

RQ2: Which original UTAUT and UTAUT2 independent variables (i.e., ease of use, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit) are the most commonly significant predictors of technology adoption in K-12 education?

The results revealed that the majority of the articles, 11 out of 14 (79%), utilized the UTAUT model, while the remaining three articles (21%) utilized the UTAUT2 model. A frequency count of the relationships employing the core constructs in the original UTAUT and UTAUT2 models – performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, and behavioral intention – highlighted performance expectancy to rank highest, with 15 instances of significantly influencing behavioral intention. Social influence ranked second, with 11 instances of significantly influencing behavioral intention. Surprisingly, effort expectancy was ranked third, with eight instances of significantly influencing behavioral intention. However, it also had the highest count of non-significant results among all the variable relationships. Table 4 shows the UTAUT and UTAUT2 variables and their respective relationships according to the models. For instance, performance expectancy directly influences behavioral intention; it is illustrated with an arrow from one variable to the other. The table provides frequency counts for statistically significant relationships, denoting positive (+) or negative (-) direction, as well as instances where relationships were not significant (NS) or omitted from a given study.

Table 4. Frequency count relationships among UTAUT and UTAUT2 core determinates

UTAUT and UTAUT2 variables	Significance			
	Yes, +	Yes, -	NS	Omitted
Performance Expectancy → BI	15	0	3	0
Effort Expectancy → BI	7	1	10	0
Social Influence → BI	10	1	4	3
*Facilitating Conditions → BI	6	0	6	3
*Hedonic Motivation → BI	2	1	0	0
*Price Value → BI	0	0	1	2
*Habit → BI	1	1	0	0
*Habit → UB	0	0	0	3
Facilitating Conditions → UB	4	0	1	13
Behavioral Intention → UB	4	0	2	9

*Represents variables only in the UTAUT2 model
BI = behavior intention
UB = use behavior
NS = not significant

CONCLUSION

This systematic literature review assessed the application of UTAUT and UTAUT2 to study technology adoption among K-12 educators, as reported in research and found in 14 applicable articles. Although past research has indicated the two models are widely used in higher education and information technology (Khechine et al., 2016; Tamilmani et al., 2021), this study observed disappointing applications in K-12 educational settings. This may be attributed to other theoretical frameworks or models being more frequently used to study this population, such as the TAM (Granić, 2022; Granić & Marangunić, 2019; Scherer & Teo, 2019), adaptations of the TAM (Teo, 2009), the GETAMEL (Abdullah & Ward, 2016), or TPACK (Mishra & Koehler, 2006). Another explanation may be the limited opportunities to study technology adoption in K-12 before the COVID-19 pandemic. The COVID-19 pandemic has forced educators of all grade levels to teach online, which has led to a greater number of educators now gaining the experience of technology adoption compared to pre-pandemic times.

This systematic review revealed a range of new variables that play a role in technology adoption among K-12 educators. Most new variables added to the models were in the perceived behavioral control category. Perceived behavioral control includes (a) ease of use, (b) a person's self-efficacy, (c) facilitating conditions, and (d) opportunities to engage with the technology (in terms of access and situational factors) (Kemp et al., 2019). In the perceived behavioral control category, five new types of self-efficacy variables were identified. This information tells us that researchers commonly study self-efficacy and consider it an important factor in understanding what influences or prevents a teacher from adopting educational technology. When UTAUT was originally developed (Venkatesh et al., 2003), self-efficacy was fully mediated by performance expectancy rather than directly impacting intentions to use technology. This was also observed in a review conducted by Bakar et al. (2018). However, our study observed in Dindar et al. (2021) that self-efficacy has a direct effect on behavioral intention. Our review discovered the second most new constructs under the attitude, affect, and motivation categories. Our results suggest the emotions, internal states, and perspectives a teacher possesses will influence their decision-making and behaviors toward educational technology. In line with previous research that highlights the significance of motivation (Backfisch et al., 2021) and attitudes (Khlaif, 2018), our findings underscore the predictive role of these factors in educator

technology adoption. A UTAUT meta-analysis showed it is common to see new variables, such as (a) attitude, (b) anxiety, (c) trust, and (d) self-efficacy, introduced into the models (Dwivedi et al., 2011; Williams et al., 2015), which was true of our results. Overall, our review, corroborated by other research, suggests approaches to understanding the factors that influence technology adoption by K-12 teachers should include measures of self-efficacy, attitudes, affect, and motivation.

This review also included an examination of the original core constructs of the UTAUT and UTAUT2 in K-12 education. In this study, *performance expectancy* frequently had the most significant positive outcomes (15). Second to that was *social influence* with 10 significant positive outcomes. Previous reviews have found performance expectancy to be the strongest predictor of behavioral intention (Chang, 2012; Dwivedi et al., 2019; Khechine et al., 2016; Williams et al., 2015). Our study demonstrates that among K-12 educators, if a technology does not perform the tasks needed to complete a given job, then users will not adopt it. Those involved in educational technology design should identify the critical tasks that users must complete and then develop the technology to support those tasks. In this study, *social influence* was the second most tested core variable (meaning, original to the model) with the most significant outcomes. Social influence and performance expectancy are commonly ranked among the top two significant predictors of technology adoption (Dečman, 2015; Williams et al., 2015). Interestingly, our review shows two pairs of relationships to be less predictable in educational environments: *effort expectancy* affecting *behavioral intention* (i.e., eight significant outcomes and ten insignificant outcomes) and *facilitating conditions* affecting *behavioral intention* (i.e., six significant outcomes and six insignificant outcomes). It is likely other mediating or moderating factors are affecting the variation in prediction.

Our review did not observe the addition of new social influence variables. Some researchers have argued for further examining social influence because there are starkly different conceptualizations of this construct (Graf-Vlachy & Buhtz, 2017). For example, evidence exists that students influence a teacher's attitudes and beliefs about technology (Ajjan & Hartshorne, 2008; Kim & Lee, 2020; Nelson, 2011; Pynoo et al., 2011), indicating that teacher-student dynamics warrant more exploration.

Observations made during coding and analysis revealed that the original moderators (*age, gender, experience, and voluntariness of use*) were often dropped from the two models or that only a subset of them were applied. Dwivedi et al. (2019) made similar observations and encouraged researchers to reconsider adding the original moderators back into the models. They posited that most studies had omitted these moderators due to an anticipated lack of variance. This result was certainly true for Lopez-Perez et al. (2019), who dropped *voluntariness* and *experience* because their teacher sample had the voluntary ability to choose the technology, and most were already familiar. In other studies, moderators were commonly omitted from the models without explanation, as seen in Ho et al. (2013), Raman and Rathakrishnan (2018), and Reychav et al. (2016). One study dropped all moderators because of cost and time (Raman et al., 2014).

At least two studies introduced new moderators into the UTAUT models. One study introduced pandemic anxiety and found it significantly influences several relationships in the given model (Jevsikova et al., 2021). At least two studies introduced teaching experience (Jevsikova et al., 2021; Šumak & Šorgo, 2016) and found some significant outcomes. Teaching experience is a new conceptualization of the original definition of experience, described as skills growing with technology over time (Venkatesh et al., 2003), which is one of the five best-studied constructs and plays a key role in explaining technology adoption (Abdullah & Ward, 2016). The findings in this review suggest that teaching experience is an important factor to include when studying technology adoption in the K-12 context.

This review revealed no new constructs related to system attributes. System attributes relate to how the system itself performs and are unrelated to the learning produced (Kemp et al., 2019). This result includes considerations such as the security, privacy, function, response, interactivity, and personalization that the system affords. While this review found no new constructs related to system

attributes, research shows that system attributes do matter. Further exploration of this construct remains warranted.

Another notable observation about this collection of articles was the tendency to rename core constructs or use them interchangeably with similar variables from other adoption models. For example, labels such as "support" instead "facilitating conditions" were used, and renaming "facilitating conditions" to "perceived behavioral control" was also found (Dindar et al., 2021; Ho et al., 2013; Kim & Lee, 2020; Omar et al., 2019). At least two articles used the original UTAUT theoretical framework but studied the relationship between facilitating conditions and behavioral intention, which is only found in the UTAUT2 framework (Pynoo et al., 2011; Raman & Rathakrishnan, 2018). These observations are problematic because they diminish consistency across studies and make interpretation of the variables and research models difficult. More consideration should be given to whether new labels are warranted according to a construct's true difference.

Limitations and Future Research

This study included observations of the outcomes of relationships: (a) according to their significance (i.e., yes or no), (b) presence (i.e., omitted or not), and (c) the directionality (i.e., inverse or direct). However, the study did not include measurements exploring the statistical extent of those relationships. As such, future research may replicate this study to see if the effect sizes or weights of those relationships provide interesting insights into understanding the phenomenon. The results might indicate that while a relationship is less common, it still yields high outcomes. The 2020 pandemic provided rich grounds for studying the effects of the core determinates, especially social influence and facilitating conditions. As more articles are published on technology adoption in K-12 education during the years of the COVID-19 pandemic, it is likely some variables will start to be omitted from research models (Dindar et al., 2021) while other variables take on more prominence. At the time of this study, few articles used the UTAUT and UTAUT2 frameworks within K-12 education. This made it difficult to extract patterns and trends for the current study's analysis.

This study contributes to the fields of IT and education in three main ways. First, this study revealed a large gap in the use of the UTAUT and UTAUT2 models within K-12 education, specifically among educators, with only 14 studies meeting the criteria. This hinders the generalizability and validity of the models in the K-12 context. Second, this study revealed the importance of *performance expectancy* and *social influence* among K-12 educators. Technology must accomplish the intended performance goal, and educators are likely influenced by their students as well as superiors and peers. Third, new variables within this domain related to perceived behavioral control themes. The environment, situation, and experience of the educator are associated with their decisions towards technology. In conclusion, this study underscores the need for scholars to dedicate additional efforts toward examining technology adoption among K-12 educators. A particular emphasis should be placed on identifying new constructs and testing new relationships among constructs, as suggested by previous studies (Bervell & Umar, 2017; Or, 2023), that can further explain the technology adoption phenomenon in K-12 contexts.

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APPENDIX: VARIABLE DEFINITIONS

The variables used in this study and their definitions are provided in alphabetical order:

- Author – names of authors
- Country – the location of the study's participants
- Education level – this describes the grade level where the participants worked coded as primary or secondary.
- Journal – name of journal
- New variables – this variable included new variables introduced and tested in the UTAUT or UTAUT2 model. Titles and definitions of the new variables were collected as provided by the author of the study.
- Participants – this describes the participant's occupation. All participants were teachers. Preservice teachers were excluded from the review.
- Publication year – the year the study was published.
- Sample size – coded a numeric value.
- Title – title of study.
- UTAUT design – this variable describes how the UTAUT or UTAUT2 models were used. Specifically, whether the authors modified it or kept the original models intact when applied to the various settings. This variable was organized into four categories: (1) UTAUT Original, (2) UTAUT Modified, (3) UTAUT2 Original, and (4) UTAUT2 Modified.

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