International Journal of Instruction
e-ISSN: 1308-1470 ● www.e-iji.net

April 2026 ● Vol.19, No.2
p-ISSN: 1694-609X
pp. 59-86

Article submission code: 20250610080824

Received: 10/06/2025
Revision: 27/09/2025

Accepted: 08/10/2025
OnlineFirst: 01/01/2026

Exploring UTAUT Research in Higher Education: A Bibliometric Analysis and Future Directions in the Era of AI and ChatGPT

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As emerging technologies evolve rapidly, understanding the determinants and barriers influencing technology use in daily life is essential. The Unified Theory of Acceptance and Use of Technology (UTAUT) model offers a valuable framework for analyzing technology adoption and use. This study examines publication trends, thematic themes, keywords, and the evolution of UTAUT research in higher education, while identifying future research directions. A comprehensive bibliometric analysis was conducted using 836 publications retrieved from Scopus (2005–2024). Employing VOSviewer and Bibliometrix, the analysis explores: (1) annual publication outputs, sources, and keywords; (2) publication trends, highly cited works, and leading researchers; (3) co-occurrence networks of UTAUT scholarship in higher education; and (4) thematic clusters and future research directions. The findings reveal steady growth in UTAUT research, reaching a peak in 2022 with 131 publications. Five major thematic clusters were identified, ranging from classical UTAUT constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) to emerging themes such as e-learning adoption, digital trust, and AI-driven tools like ChatGPT. This study highlights a critical transition: UTAUT research in higher education is increasingly intersecting with artificial intelligence, reshaping constructs such as student behavior, intention, and satisfaction. This study contributes to the identification of a transition in UTAUT research, from focusing primarily on adoption factors to engaging with the emerging challenges of artificial intelligence in higher education. This shift highlights how AI-driven educational technologies are reshaping constructs such as intention, behavior, and satisfaction. Practical implications include guiding institutions to design AI-enabled learning systems that enhance engagement. Overall, this research consolidates UTAUT scholarship while offering a forward-looking perspective that positions AI and ChatGPT at the center of higher education's digital transformation.

Keywords: bibliometric analysis, UTAUT, Higher education, E-learning, ChatGPT

Citation: Mai, W., & Khairani, A. Z. (2026). Exploring UTAUT research in higher education: A bibliometric analysis and future directions in the era of AI and ChatGPT. *International Journal of Instruction*, *19*(2), 59-86.

INTRODUCTION

Higher education is a pivotal platform for developing advanced skills, fostering critical thinking, and generating groundbreaking research, which is essential for societal advancement and economic sustainability (Alsulaimani, 2022). Concurrently, the rise of e-learning systems has become integral to this educational evolution, providing accessibility, flexibility, and a diversified learning environment that caters to a global higher education landscape. Hence, e-learning enhances learning outcomes and increases access to education, transcending geographical boundaries (Ullah et al., 2023).

Within this context, a thorough understanding of how these factors affect the adoption of e-learning is essential to effectively use e-learning as a valuable tool for higher education and students learning (Sitar-Taut, 2021). The Unified Theory of Acceptance and Use of Technology (UTAUT) model emerges as a critical analytical model in the e-learning systems. The UTAUT model, developed by Venkatesh et al. (2003), has become an essential theory in understanding the dynamics of technology adoption, particularly within higher education (Osei et al., 2022; Thuy, 2025). As aforementioned, empirical study in various fields has validated the UTAUT model, proving its significance in e-learning systems (Almaiah & Alyoussef, 2019; Chopdar, 2022; Venkatesh et al., 2003). The UTAUT model provides a framework for understanding how students and educators perceive and interact with technology in the e-learning environment. As educational landscapes rapidly shift towards digital platforms, understanding the factors driving learner acceptance and engagement with technology becomes paramount.

The UTAUT2 model was developed to enrich the original UTAUT framework, both of which aim to understand users acceptance and use of technology (Venkatesh et al., 2012). However, the main difference between UTAUT and UTAUT2 is that UTAUT2 incorporates three constructs into the concepts of hedonic motivation, price value, and habit (Venkatesh et al., 2012). Notably, the rise of consumer technology has led to the extension of the UTAUT model into consumer contexts, with UTAUT2 being more applicable in marketing environments due to its emphasis on hedonic motivation, price value, and habit (Tamilmani et al., 2021; Venkatesh et al., 2012). However, this study aims to understand the UTAUT model in higher education because the constructs of UTAUT (performance expectancy, effort expectancy, social influence, and facilitation) are highly relevant to higher education institutions. These constructs are designed to predict users acceptance and usage behavior in organizational settings (Venkatesh et al., 2003).

Bibliometric analysis has been widely used to explore the contribution of the UTAUT model in many areas. In particular, Alturas (2021) analyzing publications on technology acceptance and usage models from the past five years (2014-2018), this study primarily compared and analyzed the eight models that comprise the UTAUT model, as well as the publishing numbers associated with it. However, the document does not examine the hot words and future topics associated with the UTAUT model, and the review time is just 4 years, a relatively narrow time. A. Aytekin et al. (2022) provides a 31 bibliometric analysis of studies applying the UTAUT in the context of mobile learning adoption between 2003 and 2020, with a significant growth in publications since 2010,

particularly in the contexts of higher education and professional training. Although the UTAUT model has been widely applied in higher education to explain technology adoption, current reviews reveal several shortcomings. First, most studies cover relatively short timeframes, limiting insights into the long-term evolution of UTAUT research. Second, there is insufficient attention to emerging hot topics and future directions, even though these are essential for guiding scholarly inquiry. Third, many analyses lack comprehensive bibliometric approaches, leaving gaps in understanding influential scholars, thematic networks, and evolving trends. Finally, recent AI-driven transformations, particularly the integration of ChatGPT in higher education, remain largely absent from UTAUT-focused reviews. Addressing these gaps requires a comprehensive and longitudinal bibliometric study that not only maps publication patterns but also examines how AI and ChatGPT are reshaping UTAUT's relevance in higher education.

Thus, given the gaps in the existing literature on the UTAUT model in higher education, this study aims to provide a comprehensive and in-depth understanding of the UTAUT model in this context. Hence, this study mainly researches the following questions: (a) What are the publication trends in the UTAUT model in higher education between 2005-2024? (b) What key topic areas and major researchers have been discussed in the UTAUT model in higher education, and (c) What is the connection between author keywords? (d) How has the UTAUT model in higher education research evolved and the future research trends? Therefore, this paper mainly focuses on the following objectives: (1) The annual number of published research, sources, keywords. (2) The publication trend, highly cited publications, top researchers. (3) The co-occurrence analysis of researchers working on the UTAUT model in higher education. (4) The thematic trends and future directions the UTAUT model in higher education.

This study makes three contributions that directly address these gaps. (1) It offers a higher education-specific, longitudinal bibliometric synthesis of UTAUT from 2005 to 2024, mapping publication trends, co-occurrence network, and thematic evolution over nearly two decades. This analytical scope extends beyond the limited timeframe of prior research and subdomain-specific reviews. (2) It explicitly traces where and how AI/ChatGPT-related terms have entered the UTAUT knowledge network in higher education, thereby clarifying the field's recent pivot toward AI. This positions the study not only as a review of past work but also as a guide for future research on the UTAUT model in the era of AI.

LITERATURE REVIEW

Evolution of UTAUT Model

Since the UTAUT model was proposed in 2003, the UTAUT model has become a crucial framework for studying technology acceptance (Venkatesh et al., 2003). In the initial stages, UTAUT research primarily concentrated on its foundational framework and assessed its applicability across various technological domains. Scholars investigated factors influencing user acceptance of new technologies (Duenas-Rugnon et al., 2012; Dulle & Minishi-Majanja, 2011; Duyck et al., 2008). Key research topics during this period included "performance expectancy" (Duenas-Rugnon et al., 2012), "user acceptance". By focusing on these topics, early studies laid the groundwork for

understanding the diverse factors influencing technology adoption behaviors. From 2020 to 2022, UTAUT research shifted into an expansion and application phase. The research focus gradually shifted towards specific technological application scenarios such as " technology acceptance" (Paul et al., 2024), "technology use" (Alshahrani, 2023), and "higher education" (Paul et al., 2024) and "social influence" (Arruda et al., 2022; Donmez-Turan, 2020). From 2023 to 2024, most studies highlight new research topics such as "digital health" (Baik et al., 2023), "artificial intelligence" (Chatterjee et al., 2023), "internet of things" (Ronaghi & Forouharfar, 2020), and "sustainability" (Arpaci et al., 2022). Furthermore, "meta-UTAUT" has emerged as a new research direction, indicating that scholars are beginning to perform meta-analyses to explore the consistency and differences of the UTAUT model across various culture (Alsulaimani, 2022; Chatterjee et al., 2023). Recent developments since 2020 have demonstrated that the UTAUT has evolved significantly in higher education, particularly with the integration of artificial intelligence (AI). While the original constructs—performance expectancy, effort expectancy, social influence, and facilitating conditions—remain central, new variables have emerged to capture AI-specific concerns (Chiu, 2025). Studies highlight the growing importance of trust in AI, transparency, and ethical considerations in shaping teachers' and students' intentions to adopt AI-based tools (Zhang et al., 2025). For students, variables such as AI literacy, perceived transparency, and readiness complement motivational and social influences, particularly in the context of generative AI applications like ChatGPT (Alshammari, 2025; Dertli & Yildiz, 2025; Kemouss & Khaldi, 2025; Yakubu et al., 2025). Systematic reviews further show that UTAUT model applications frequently integrate trust, and privacy concerns, underscoring a broader shift toward socio-ethical and behavioral dimensions of AI adoption (Khanfar et al., 2025; Wagner et al., 2022). Accordingly, a conceptual framework should retain the core UTAUT constructs while incorporating these AI-specific extensions to reflect contemporary trends in higher education.

Overall, research trends in the UTAUT model have evolved from theoretical construction to practical application and the exploration of emerging technologies. However, most empirical works rely on single-institution surveys with UTAUT constructs, lacking longitudinal, cross-context, or cross-cultural synthesis. And there is little bibliometric work tracking how UTAUT research themes and terminologies evolve over time, especially in relation to emerging technologies.

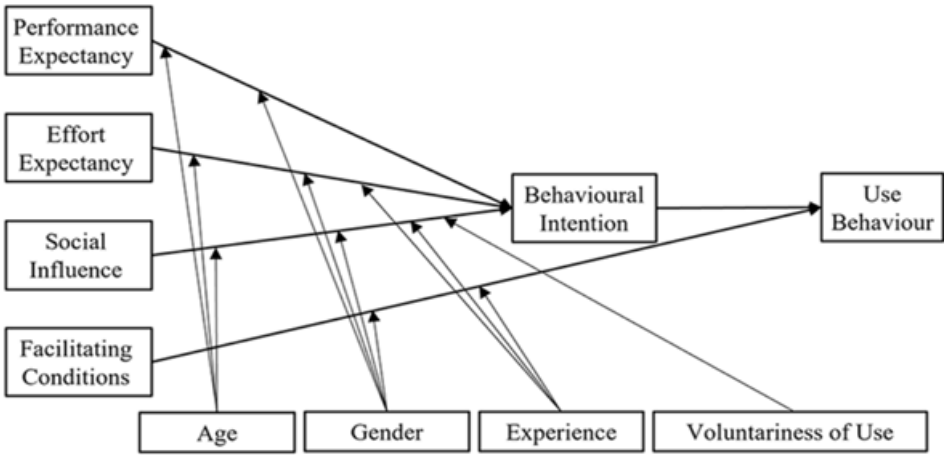

Figure 1
UTAUT model adopted from (Venkatesh et al., 2003)

Past Studies

Accompanying the extensive use of the UTAUT model are numerous literature reviews. Williams et al. (2012) indicate that the UTAUT model has become a popular theoretical choice for the adoption of information technology. The study collected 128 papers from 2004 to 2010 for analysis, including citation rate, keywords, high-frequency words, etc. However, it still lacks the contribution of the most important countries and institutions in the analysis, as well as future trends analysis. While comprehensive, this study did not examine the role of leading countries or institutions, nor did it forecast emerging research themes. The research that Granic (2022) uses is a meta-analysis and comparison of TAM and UTAUT. This study was based on a keyword search of the literature from 1998 to 2021, which shows the publication date and country, technology type, participants, sample size, and literature analysis of factors affecting the adoption of educational technology. However, this literature analysis primarily analyzed TAM and UTAUT from the perspective of technology adoption, lacking an in-depth review, UTAUT hot words, and future research. A. Aytekin et al. (2022) conduct a systematic review of 31 studies published between 2003 and 2020 that applied the UTAUT model to mobile learning in the higher education. Their work highlights the relevance of the UTAUT model in understanding the adoption of e-learning technologies in academic settings. Most reviews cover either broad technology adoption or specific subdomains (e.g., mobile learning) rather than offering a holistic, higher education focused synthesis over time. Similarly, Ortega Azurduy (2021) examines 414 articles published from 2006 to 2021, focusing on e-learning adoption and use trends in higher education. Additionally, Xue et al. (2024) in a systematic review of the UTAUT model in higher evaluated 162 SSCI and SCI articles published from 2008 to 2022, and called for future UTAUT applications to require research that encompasses different disciplines, mixed methods, and theoretical perspectives.

Nikolic et al. (2024) conducted a systematic literature review to demonstrate that while academics generally hold a positive view of UATUT in AI, its adoption is constrained by issues of reliability, ethical challenges, and insufficient institutional guidelines. Importantly, the review highlights that UTAUT has not yet been applied to AI research, revealing a significant gap in the literature. Granić (2024) reviews seventeen major technology adoption models and notes that UTAUT plays a central role by integrating earlier theories. They emphasize its four core predictors—performance expectancy, effort expectancy, social influence, and facilitating conditions, as key factors shaping behavioral intention and technology use. Ma (2025) systematically reviewed the literature on ChatGPT in higher education, employing both bibliometric and qualitative approaches. Among the theoretical models applied, UTAUT was highlighted as a valid framework for examining factors that shape students' acceptance and usage of ChatGPT. The authors note that constructs such as performance expectancy, effort expectancy, social influence, and facilitating conditions remain highly relevant in predicting behavioral intention, thereby confirming the applicability of UTAUT to emerging AI tools in education. While prior studies confirm UTAUT's importance, limited provide a systematic, higher-education specific bibliometric synthesis that (1) traces the longitudinal trajectory of UTAUT research, (2) connects traditional adoption constructs with the integration of emerging AI technologies such as ChatGPT, and (3) critically evaluates thematic evolution and future directions in this domain. This study directly addresses this gap by offering the first longitudinal bibliometric analysis of UTAUT in higher education (2005–2024). It is worthy noted that few studies use bibliometric tools to trace how themes evolve, with little attention to keyword dynamics or structural role of terms across periods, and reviews prior to 2022 seldom incorporate AI, ChatGPT, or similar innovations into their analysis of UTAUT's evolution.

Research Gap

Despite the extensive research, several gaps still need to be filled. First, there is a lack of longitudinal studies that examine the evolution of UTAUT applications in higher education over an extended period. Most existing studies focus on short-term analyses, which fail to capture long-term trends and shifts in how technology acceptance model adapt to changing educational and technological landscapes (Al-Mamary, 2022). Additionally, systematic evaluations of UTAUT in higher education are limited (Xue et al., 2024), and study identifies new directions and hot words in the literature while visualizing these trends using advanced bibliometric tools. Thirdly, few research has traced the dynamic conceptual transformations within the field. This study aims to understand how the thematic focus has shifted from traditional e-learning environments to AI-driven personalized learning experiences, offering deeper insights into the evolving patterns of technology adoption in academia. Addressing this gap is crucial for identifying research trajectories, ensuring that UTAUT continues to adapt to emerging technological paradigms in higher education. This study conducts a comprehensive, longitudinal bibliometric synthesis of UTAUT in higher education from 2005 to 2024, covering broader technology contexts beyond mobile learning and e-learning, with larger sample sizes. It maps the thematic evolution, showing how core UTAUT constructs persist and how new developments, such as AI and ChatGPT, have become central to the discourse. It grounds future directions in empirical evidence, offering

theory-based predictions rather than descriptive summaries—thus acting as both a structural overview and a roadmap for upcoming UTAUT research in the AI era. It applies a bibliometric procedure (Scopus search strategy, keyword normalization, VOSviewer, and Bibliometrix tools) to ensure reproducibility and generate reliable insights for both theory and practice. By sharpening the focus on higher education and integrating new AI-related themes, this study offers a contribution that advances understanding of UTAUT theory in the context of rapid digital transformation.

METHOD

Bibliometrics is a statistical method for analyzing published literature, focusing on key concepts, research trends, methods, keywords, citations, and sources. It serves as a valuable tool for literature reviews, offering a scientific mapping of data to enhance understanding of a field's evolution. This study employs bibliometric methods from Zupic and Čater (2015) to establish a structured research approach, specifically targeting the UTAUT model in higher education.

Besides, to refine collected data, OpenRefine is a valuable tool for data organization, allowing for efficient data filtering, cleaning, and transformation. We utilized OpenRefine version 3.8.5 to refine and streamline author keywords to facilitate this process (Ghasemy et al., 2023). This involved consolidating variations such as "University", "Universities"; "HEI", "HEIs", "higher education institutions", "higher education institution"; "The Unified Theory of Acceptance and Use of Technology", and "the utaut model", "utaut model", "unified theory of acceptance", "unified theory of acceptance and use", "unified theory of acceptance and use technology(utaut)"; "eLearning", "elearning"; "ehealth literacy", "e-health literacy" etc. As a result, this study ultimately generating 1,540 distinct author keywords.

Data Source and Defining Keywords

A bibliometric analysis was conducted using the Scopus database as of July 20, 2024, focusing on the Unified Theory of Acceptance and Use of Technology (UTAUT) in higher education. The Scopus online database was selected for this study as it is widely recognized as the most significant citation and abstract database for technology, social sciences (including higher education), business, and management. Furthermore, all peer-reviewed articles published in the Scopus online database are from renowned and leading academic publishers, such as Elsevier, Emerald, Taylor and Francis, Springer, ensuring comprehensive institution profiles and authoritative authors (Alper Aytekin et al., 2022). When conducting bibliometric research, appropriate keywords are essential (Zhao & Abdullah, 2025). The study employed specific keywords, including "UTAUT" OR "unified theory of acceptance and use of technology" AND "Higher education" OR "University" OR "College," to retrieve relevant articles English languages. The focus on article titles is because they are crucial in facilitating article retrieval and reading (Zhao & Abdullah, 2025). The study scope is extended to publications up to July 20, 2024, to capture the latest trends and historical research on UTAUT in higher education. Errata and retractions were removed to prevent duplication or inclusion of inaccurate documents in the counting process (Ghasemy et al., 2023). For the Inclusion and exclusion criteria, publications were retrieved from the Scopus database between 2005

and 2024 using the keywords "UTAUT" AND "higher education". Non-English language documents were excluded, as they contribute minimally to research trends. This approach ensured both comprehensiveness and comparability across studies.

Tool and Search Strategy

As Aria and Cuccurullo (2017) emphasized, conducting bibliometric analysis requires scientific cartographic analysis. Moreover, to ensure the precision of the query outcomes, it is imperative to confine the research scope to UTAUT theory in higher education. Subsequently, a thorough manual inspection resulted in exporting final 836 publications from the Scopus database in CVS format via employing PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach (Zhao & Abdullah, 2025), as shown in Figure 2, it illustrates the search strategy in this research. In the study need errata, and retractions were removed to prevent duplication or inclusion of inaccurate documents in the counting process (Ghasemy et al., 2023). To address this research objectives and research questions, this study employ (i) Microsoft Excel 2019 to calculate the frequency and citation metrics of the published material and generate relevant charts and graphs; (ii) VOSviewer (version 1.6.19) to create and visualize bibliometric networks; and (iii) Bibliometrix R package (version 4.3.1), specifically utilizing Biblioshiny to generate thematic keyword and research trend plots.

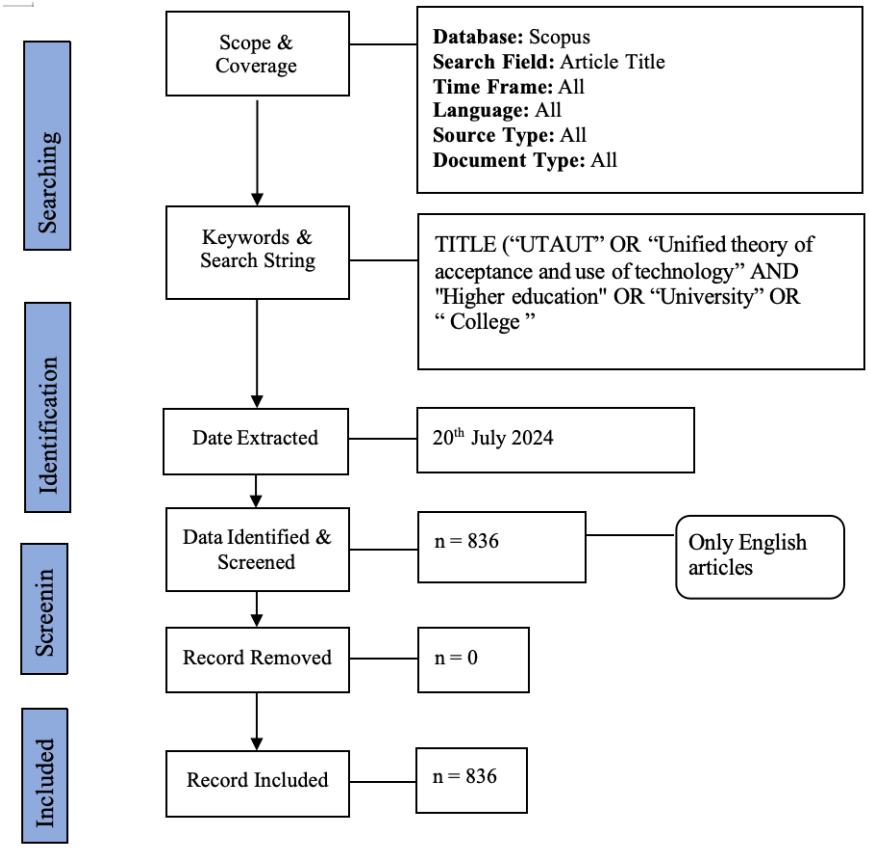

Figure 2 Flowchart of systematic review process
Flow diagram of the search strategy. Sources: Authors own do.

FINDINGS

Document profile

Based on document types and source types, the Scopus database identified 836 documents, all the documents are English, non-English papers are excluded in this study. These documents include a journal, conference, book series, book and trade journal. Figure 3 summarizes the composition of the publications by document type, journals are the most common source, accounting for three-quarters (598) of the total number of published documents, followed by Conference Papers (166), and other document types, each constituting less than 1% of the total publications.

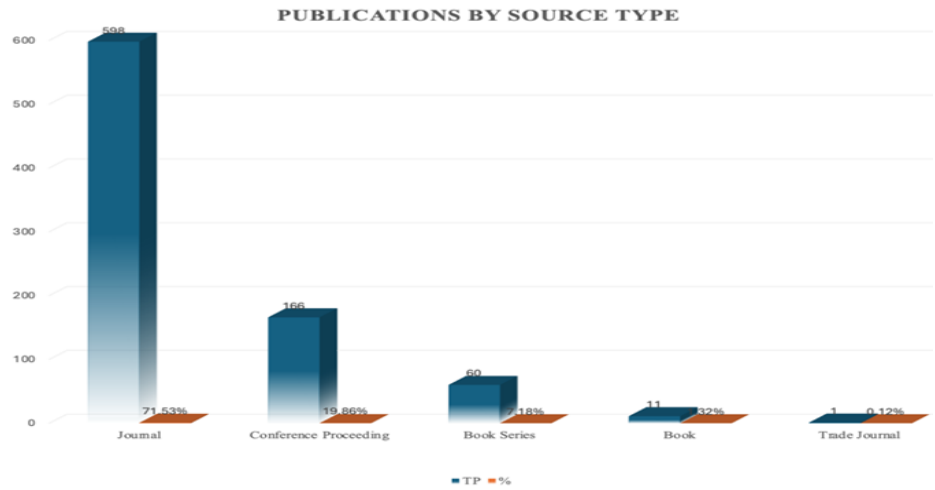

Figure 3
Publications by source type (N=836)

Publication trend

Table 1 details the annual citation matrix for literature from 2005 to 2024, highlighting a peak in publications in 2022 (131), followed by 2023 (128) and 2024 (122). The year 2005 recorded the lowest citations per publication (0), attributed to the UTAUT model's extensive publication history. Figure 6 illustrates the trends in publication and citation. The surge in 2022 reflects increased interest, evidenced by rising total citations (TC), although citations per publication (C/P) and citations per cited publication (C/CP) declined, indicating a potential decrease in the average impact of individual studies. Nonetheless, the increasing h-index and g-index suggest a sustained overall impact in the field. Several factors may explain the publication surge in 2022. The Figure 4 also demonstrates a peak in citations around 2019, followed by a decline, whereas the number of publications has remained relatively high in recent years, indicating sustained scholarly interest in the model. The COVID-19 pandemic's emphasis on digital transformation in education likely spurred interest in remote teaching and learning, driving research on the UTAUT model (Patil & Undale, 2023). Consequently, e-learning has gained significant prominence due to its crucial role in ensuring educational continuity during this period, attracting considerable attention from both industry practitioners and academics globally (Osei et al., 2022). Importantly, the surge during COVID-19 should not be viewed merely as a temporary reaction to emergency remote teaching, but as a turning point in the theoretical development of technology acceptance models (Rawas, 2024). This suggests that UTAUT in higher education is shifting from validating existing constructs toward adapting and extending them to capture AI-driven and post-pandemic learning environments. From a practical perspective, the sustained volume of publications after 2020 imply that universities should be consider long-term integration of digital and AI-based tools rather than short-term solutions (Parker et al., 2024).

Table 1
Year of publication and citation matrix

Year	TP	NCP	TC	C/P	C/CP	*h*	*g*
2005	1	0	0	0.00	0.00	0	0
2006	1	1	14	14.00	14.00	1	1
2007	4	3	41	10.25	13.67	3	4
2008	3	3	353	117.67	117.67	3	3
2009	4	2	47	11.75	23.50	2	4
2010	10	9	238	23.80	26.44	5	10
2011	6	6	150	25.00	25.00	5	6
2012	10	9	176	17.60	19.56	7	10
2013	21	20	1188	56.57	59.40	12	21
2014	21	17	585	27.86	34.41	9	21
2015	26	26	944	36.31	36.31	14	26
2016	26	24	1224	47.08	51.00	13	26
2017	43	42	1193	27.74	28.40	16	34
2018	42	37	1063	25.31	28.73	18	32
2019	94	83	2964	31.53	35.71	28	53
2020	68	64	1913	28.13	29.89	22	43
2021	75	73	1729	23.05	23.68	23	40
2022	131	107	1612	12.31	15.07	22	34
2023	128	94	735	5.74	7.82	15	21
2024	122	47	201	1.65	4.28	7	10
Total	836	667	16370	19.58	24.54		

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

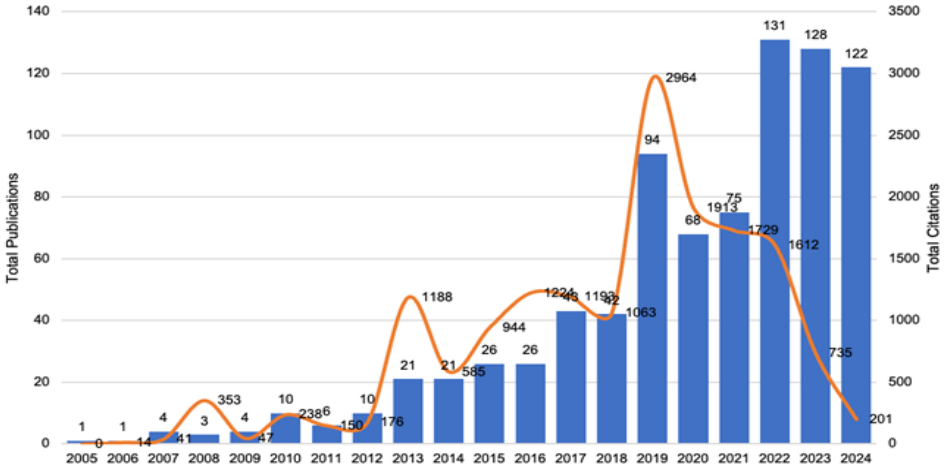

Figure 4
Publication and citation trend of UTAUT model in higher education

Co-Occurrence Analysis

This study employed VOSviewer 1.6.19 to analyze the co-occurrence network, a method used to map relationships between key concepts in a research field (Yu et al., 2019). Based on 836 publications, 1540 keywords were identified, with a minimum occurrence threshold of 10. Figure 5 presents the co-occurrence network, divided into five clusters; the different colors indicate distinct thematic clusters, each representing a key research stream within UTAUT-related studies in higher education. More specifically, at its core, the yellow cluster reflects the integration of emerging technologies, particularly AI and ChatGPT, into higher education research. The green cluster centers on UTAUT's four core constructs—performance expectancy, effort expectancy, social influence, and facilitating conditions—highlighting their enduring relevance. The red cluster encompasses moderating factors and methodological refinements, while the blue cluster highlights e-learning adoption across diverse contexts, demonstrating UTAUT's global applicability. The purple cluster focuses on UTAUT as the central framework linking technology adoption and usage. And each represented by different colors. The size of words and circles reflects keyword frequency, while node proximity indicates the strength of their co-occurrence relationships (Yu et al., 2019).

Cluster 1: Technological integration in higher education

Yellow Cluster coverer the most inter-related key terms in this data include "higher education (147)", "Covid-19 (39)", "artificial intelligence (20)", "ChatGPT (18)", "students (18)". The research trends within the blue cluster reveal that the UTAUT model has been widely utilized to analyze and predict students' adoption behaviors regarding emerging technologies, such as artificial intelligence and chatbots. Furthermore, higher education institutions are increasingly employing technological tools to enhance both teaching and learning efficiencies, particularly in the contexts of distance education and e-learning environments. This emphasis on technology integration reflects a strategic approach to optimizing educational practices in response to evolving digital advancements (Sitar-Taut, 2021).

Cluster 2: Determinants of technology acceptance and usage behavior

Green cluster brings key terms such as "behavioral intention (40)", "usage behavior (40)", "performance expectancy (30)", "social influence (24)", and "effort expectancy (24)". This smaller cluster is tightly focused on the UTAUT model constructs, providing a clear indication that the research in this area is dedicated to understanding the determinants of technology acceptance and usage. The central concept of "behavior intention" is emphasized by Yang et al. (2019). In summary, these terms are central to the network and indicate the primary focus of the research within this field. The size of the nodes in this visualization map for each term, and it represent the frequency of these keywords in the literature. Larger nodes indicate more frequently discussed topics, signaling their importance and centrality to the field (Martins et al., 2022).

Cluster 3: Moderating factors and methodology in technology acceptance

Red Cluster mainly focus on the "PLS-SEM (27)", "intention to use (18)", "moderating effect (11)", "university staff and students (10)". This cluster represents the intersection of e-learning environments, technology, and education. In e-learning and management system, the purpose of UTAUT theory in the context of higher education is to enable students, teachers to use e-learning (Alsulaimani, 2022; Thuy, 2025). Furthermore, student use technology system serves as a crucial prerequisite for enhancing and implementing the UTAUT model (Sitar-Taut, 2021). Research trends show that moderate variables and trust elements are often discussed (Saprikis et al., 2021). The keywords of "PLS-SEM" shows a strong methodological in this research area, which allows the investigation of intricate connections between variables in studies of educational technology.

Cluster 4: E-learning adoption in diverse educational contexts

Key nodes identified blue cluster include "e-learning (130)", "social media (26)", "Saudi arabia (22)", "adoption (16)", and "blended learning (10)" within the educational domain. Key nodes identified include "technology adoption", "universities", and "social media". From the perspective of research trends, these nodes primarily highlight the increasing application of social media and mobile technologies in education. Notably, they have played a pivotal role in facilitating the implementation of blended learning models.

Cluster 5: Frameworks of technology acceptance in educational research

Key terms in the purple cluster include "UTAUT (130)", "technology acceptance (97)", "tam (31)", and "gender (12)". The purple cluster reflects that TAM and UTAUT aim to understand users' intention to accept technology and usage behavior. TAM's core variables include "perceived usefulness" and "perceived ease of use", while UTAUT further integrates social influence and facilitating conditions. Future research will explore how to compare or combine the Technology Acceptance Model (TAM) and UTAUT (Pham & Dau, 2022).

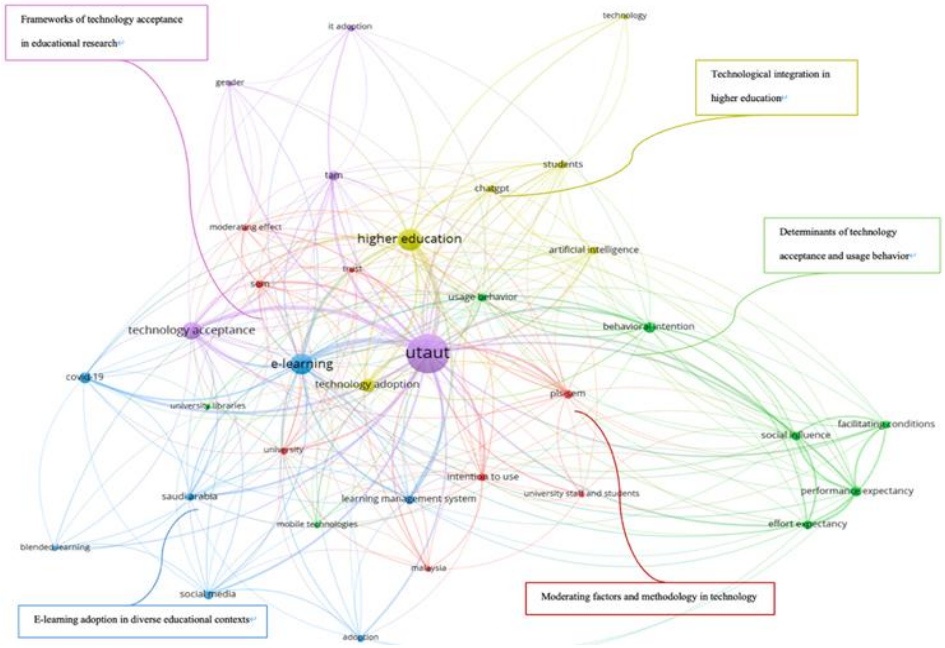

Figure 5
VOSviewer visualization of a term co-occurrence network based on title fields

Thematic Evolution

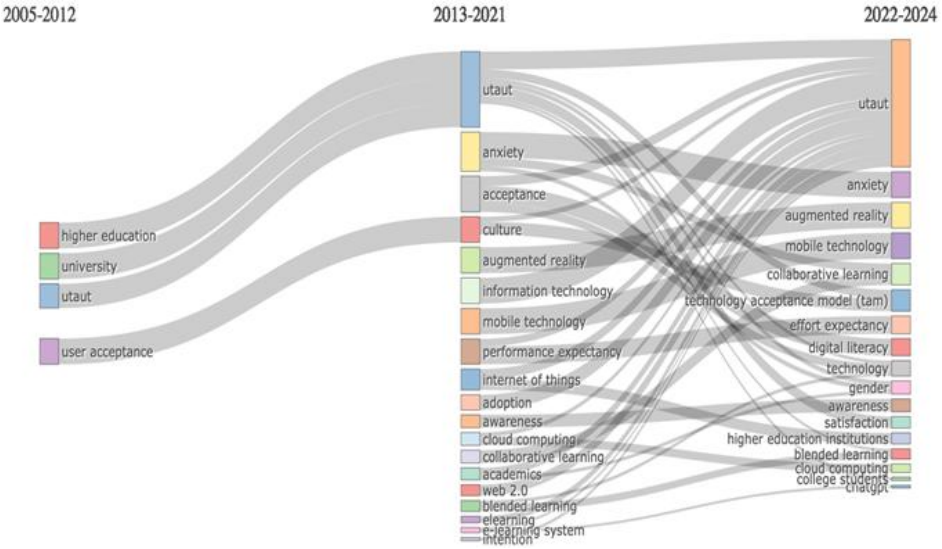

Figure 6
Thematic evolution (based on the author's keywords)

Figure 6 presents a detailed thematic evolution map generated through an extensive analysis of the author keywords using the UTAUT model in higher education. As noted by Cobo et al. (2011), this thematic evolution map offers crucial insights into the development of UTAUT theory. The map was created using bibliometrix R-package default settings—such as a word count of 250, a minimum cluster frequency of 5 per thousand documents, a weight index based on word co-occurrences, a minimum weight index of 0.1, and the Walktrap clustering algorithm—while adjusting the number of time slices to 2. To capture the longitudinal evolution of UTAUT-related research, we employed time slicing in three-year intervals (2005–2012, 2013–2021, 2022–2024). This technique allowed us to detect shifts in thematic focus, identify the emergence of new research areas, and analyze the dynamic evolution of keywords and co-citation clusters.

The thematic evolution map illustrates the progression of research on UTAUT in higher education over time. In the first phase (2005–2012), early studies focused on broad themes, including higher education, university settings, user acceptance, and the UTAUT model itself. During 2013–2021, the focus expanded to include constructs such as performance expectancy, mobile technology, and blended learning, alongside new topics like culture, anxiety, and augmented reality, reflecting a diversification of applications. In the most recent phase (2022–2024), the themes further evolved to focus on AI-driven contexts, emphasizing digital literacy, collaborative learning, and higher education institutions, while UTAUT remained central. This progression demonstrates a clear thematic shift: from general acceptance frameworks to diverse contexts of technology adoption, and finally to the integration of emerging technologies and institutional practices in higher education.

The rationale for selecting 2012 and 2021 as dividing points in our analysis is grounded in observable trends from Table 1. Year of Publication and Citation Matrix, which indicates a clear upward trajectory in UTAUT-related studies during the period from 2005 to 2012. Thus, this time frame was chosen as the first phase to capture the initial growth in research interest. For the second and third phases (2013–2021; 2022-2024), we focused on this period to emphasize the impact of COVID-19, which necessitated a global shift toward e-learning in higher education (Patil & Undale, 2023).

Thematic evolution in UTAUT research within higher education highlights its central role while expanding into subfields such as e-learning and student behavior. The increasing integration of technology is evident in themes like collaborative and blended learning. Recent studies emphasize psychological and sociological factors, including anxiety, effort expectancy, and gender, underscoring a shift toward personalized user experiences (Chopdar, 2022; Donmez-Turan, 2020). While TAM remains a foundational model, its limitations in accounting for social influence and facilitating conditions have led to the adoption of UTAUT, which introduces additional explanatory variables. Consequently, integrating TAM and UTAUT offers a more comprehensive framework for examining e-learning system adoption (Altalhi, 2021; Pham & Dau, 2022).

Thematic map is used to illustrate the conceptual evolution within a research field, offering a visual method to graphically display how themes have developed over time (Cobo et al., 2011). Additionally, the study explains the significance of each quadrant and evaluates the thematic evolution map of author keywords across three distinct time slices. 2005-2012, 2013-2021, and 2022-2024. According to Cobo et al. (2011) and Ghasemy et al. (2023), the research thematic map is a graphical representation that thematic maps divide themes into four quadrants:

The thematic analysis of our research reveals four distinct quadrants, each with unique characteristics and significance. In the upper right quadrant, we find the Motor Themes. These themes are pivotal in shaping the research field due to their robustness and centrality. They exhibit substantial internal development and maintain significant connections with other related themes, highlighting their extensive interlinks within the conceptual framework.

In the upper left quadrant, the Niche Themes are situated. These themes possess strong internal cohesion but suffer from limited external connections, rendering them less influential in the broader context of the field. Their highly specialized nature places them in a marginal position within the thematic network.

The lower left quadrant is occupied by the Emerging or Declining Themes. These themes are characterized by their underdeveloped and peripheral nature, exhibiting low density and centrality. They either represent nascent areas of research or themes that are gradually fading in relevance. Lastly, the lower-right quadrant contains themes that are significant for a research area but are still underdeveloped. This quadrant typically includes fundamental themes that are broad in scope.

Thematic map (2005-2012)

As illustrated in Figure 7, this study has delineated author keywords spanning from 2005 to 2012. Each cluster represents the keyword that appears most frequently in themes, and these clusters are considered themes. The size of the circles reflects the frequency of keywords, with larger circles indicating higher frequency in this topic, conversely, smaller circles denote lower impact (Cobo et al., 2011).

In the chart, from 2005 to 2012, UTAUT research in higher education lacked dominant driving themes, as evidenced by the absence of Motor Themes. User acceptance and university were classified as Niche Themes, indicating specialized yet constrained research without significant expansion. Learning management systems and higher education appeared in the Emerging or Declining Themes quadrant, reflecting either the early-stage development of e-learning technologies or a decline in relevance. Meanwhile, foundational themes such as UTAUT, technology acceptance, e-learning, and mobile commerce were categorized as Basic Themes, serving as the conceptual framework for subsequent thematic development from 2013 to 2024, as illustrated in Figures 8 and 9.

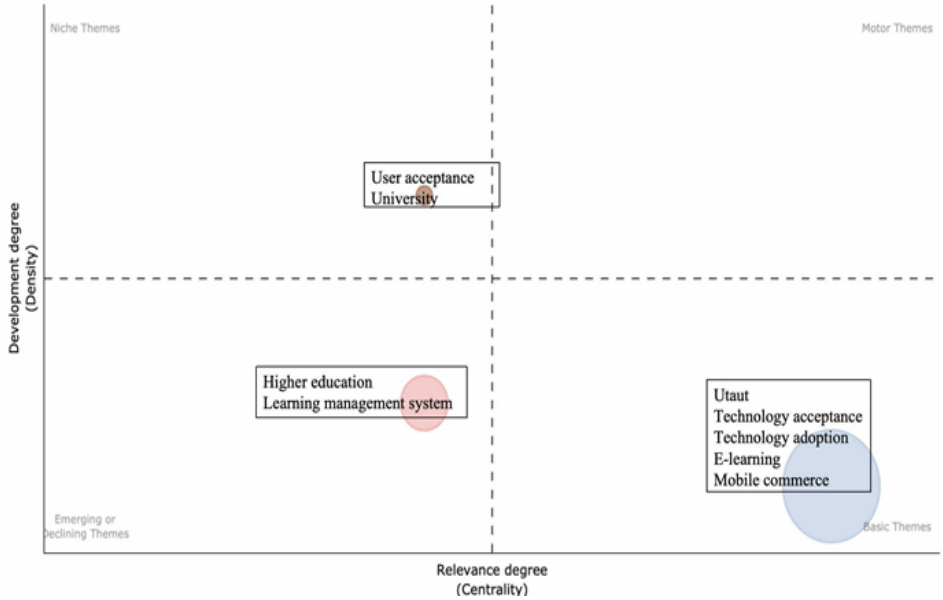

Figure 7
Thematic evolution (2005-2012)

Thematic map (2013-2021)

Based on Figure 8, this study identified 26 main clusters of author keywords. Motor themes are characterized by high centrality and high density, indicating they are well-developed and integrated into the broader research field, those terms are E-learning system, Behavior intention, Anxiety, Gender, Enjoyment, Culture, and Website Service Quality etc.

Middle east, College student, Awareness, Collaborative learning keywords show the niche themes, and it means those topics are significant density but relatively lower centrality, indicating focused but not widely adopted research areas. UTAUT, South Africa, educational innovation, teaching and learning in 2013-2021 are the Emerging or Declining Themes. Basic Themes show the foundational themes have high centrality but lower density, indicating they are fundamental: Effort Expectancy, Performance Expectancy, and Facilitating Conditions. These constructs from the UTAUT model remain central in understanding user acceptance of educational technologies. The diverse yet interconnected themes like IT (Ronaghi & Forouharfar, 2020), Mobile phone (Ullah et al., 2023), and Adoption (Patil & Undale, 2023) in the "Basic Themes" quadrant reflect the multifaceted nature of research in technology acceptance within higher education. These foundational topics are continuously being examined in various contexts (e.g., different cultural settings and types of technology) to address evolving educational challenges. In conclusion, compared with the dynamic evolution in the early stage, this period has obvious diversified evolution. During

2013-202, the research topics of UTAUT model in higher education are rich and cross-cultural, which not only ensures the research of basic theories but also has innovation.

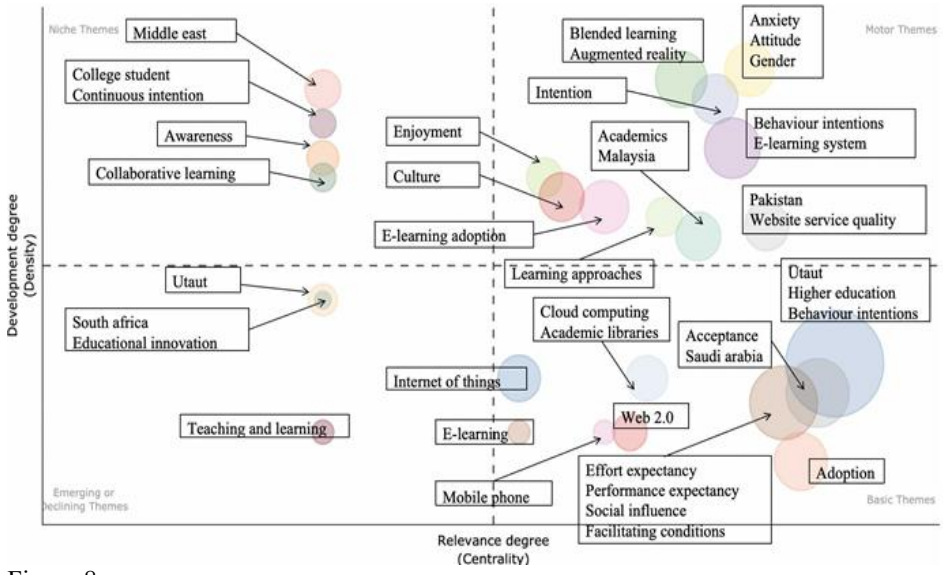

Figure 8
Thematic evolution (2013-2021)

Thematic map (2022-2024)

In the latest time slice, spanning from 2022 to 2024 as shown in Figure 9, the study identified 19 clusters of author keywords. From 2022 to 2024, UTAUT research in higher education has evolved into diverse and sophisticated themes. Motor themes, such as collaborative learning, trust, satisfaction, gender, awareness, and student engagement, reflect the growing emphasis on technology-enhanced interaction and motivation in online education, particularly during the pandemic (Alsulaimani, 2022; Chao, 2019). Niche themes, including open government data, digital technology, and virtual education, focus on specialized applications, while emerging themes, such as technology-enhanced learning, TAM, and mobile technology, indicate rising research interest.

Basic themes, such as UTAUT, higher education, effort expectancy, performance expectancy, social influence, facilitating conditions, ChatGPT, artificial intelligence, and anxiety, have remained central in 2021–2024. The widespread adoption of online learning during the COVID-19 pandemic underscored UTAUT's role in assessing user acceptance and behavioral intentions. Notably, anxiety emerged as a moderating factor influencing technology adoption, either strengthening or weakening the relationship between behavioral intention and usage (Chopdar, 2022; Donmez-Turan, 2020)..

The rise of AI tools like ChatGPT has introduced new opportunities for personalized learning, offering tailored support in summarization, translation, and comprehension

(Rawas, 2024). Recent studies applying UTAUT to ChatGPT adoption highlight performance expectancy, effort expectancy, social influence, and facilitating conditions as key predictors of its acceptance in education (Budhathoki et al., 2024; Menon & Shilpa, 2023; Strzelecki, 2023). For instance, Foroughi et al. (2024) find that Malaysian university students are receptive to integrating ChatGPT into academic activities.

Overall, UTAUT research in higher education from 2022 to 2024 reflects a shift toward more holistic and complex approaches to technology adoption, integrating AI-driven innovations and psychological factors to enhance learning experiences.

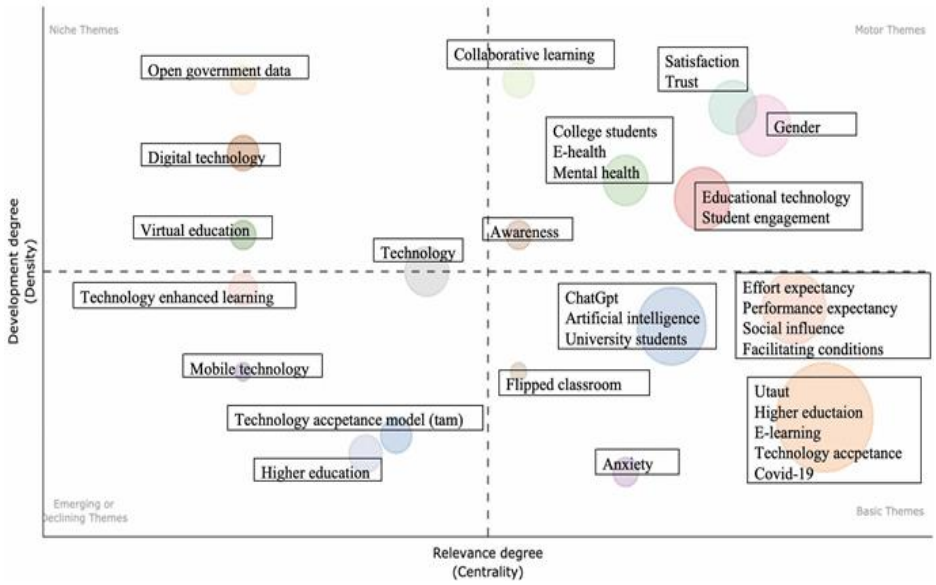

Figure 9
Thematic evolution (2022–2024)

IMPLICATION

Based on the four main research questions, a summary of key findings is presented: Firstly, the bibliometric exploration of the UTAUT model in higher education yields several pivotal insights. A comprehensive search identified a corpus of 836 all-English documents, predominantly journals (598, 71.53%), conferences (166, 19.86%), and books (60, 7.18%). Secondly, publication and citation patterns exhibit a consistent upward trajectory, notably punctuated by a substantial increase in 2019, a phenomenon attributed to the COVID-19 pandemic that necessitated the migration of educational activities to digital platforms. Publication and citation patterns exhibit a steady upward trend, with a notable increase in 2019. This surge coincides with the COVID-19 pandemic, when higher education rapidly shifted to digital platforms, highlighting the growing reliance on UTAUT-related frameworks to study technology adoption. Thirdly, Co-occurrence analysis reveals the high frequency of terms such as “UTAUT”, “higher education”, “e-learning”, “technology adoption”, “technology

acceptance", and "behavioral intention". The co-occurrence network reveals strong linkages among UTAUT constructs and broader concepts in higher education. The prominence of keywords such as "learning management system," "collaborative learning," and "behavioral intention" highlights the interdependence between technology design and user acceptance. Fourthly, based on the observed thematic evolution, the findings indicate that the UTAUT model within higher education expanded and diversified its themes from 2005 to 2024. According to the thematic map, future research focuses on "ChatGPT" and "artificial intelligence" in higher education. According to the thematic map, future research directions are strongly associated with "ChatGPT" and "artificial intelligence," signaling a new phase in which UTAUT will need theoretical refinement to address the challenges of AI-driven education.

While the rise of AI and ChatGPT is highlighted as a future direction, this trend also introduces significant challenges. As Lai et al. (2024) mention, ethical concerns, such as data privacy and academic integrity, remain underexplored in current UTAUT-based studies. Without addressing these issues, the integration of AI tools may amplify inequalities in access and trust, limiting their sustainable adoption in higher education (Rawas, 2024). Compared with earlier bibliometric reviews (e.g., Williams et al., 2015; Aytekin et al., 2022; Xue et al., 2024), which primarily summarized adoption factors or specific domains, such as mobile learning, this study uniquely captures the long-term evolution of UTAUT themes. It explicitly identifies how AI-related topics are being incorporated into the discourse. This study uniquely captures the long-term evolution of UTAUT themes and explicitly identifies how AI-related topics are entering the discourse. This broader temporal and thematic scope strengthen the originality of the contribution.

In summary, these findings collectively demonstrate that the UTAUT model remains a cornerstone in understanding technology adoption in higher education, while also evolving to accommodate new digital realities such as AI integration.

CONCLUSION

We analyzed all the literature using bibliometric methods, primarily focusing on co-occurrence analysis and trend analysis, to understand the factors that educators and learners in higher education embrace regarding technology use. Co-occurrence analysis highlights the high frequency of terms such as "UTAUT," "higher education," "e-learning," "technology adoption," "technology acceptance," and "behavioral intention," underscoring the UTAUT model's central role in understanding technology adoption in educational contexts. E-learning, encompassing learning management systems and educational software, plays a critical role in supporting innovative teaching methods and data-driven decision-making (Rawas, 2024). The prominence of hot words suggests their strong association with learning behaviors and strategies in e-learning environments. Successful technology implementation depends not only on its innovativeness but also on user acceptance and engagement (Patil & Undale, 2023).. Behavioral intention (BI) has emerged as a key research focus, as it directly predicts technology usage behavior and is influenced by performance expectancy, effort

expectancy, social influence, and facilitating conditions (Bayaga & du Plessis, 2024).. Overall, these findings reinforce the UTAUT model's utility in explaining how ease of use and perceived usefulness shape students' acceptance of e-learning technologies (Alshahrani, 2023). To enhance technology adoption, higher education institutions must provide robust technological support and continuous professional development for educators (Chau, 2024; Rawas, 2024). The findings indicate that the rise of e-learning and AI-related themes suggests that UTAUT research is shifting from simply validating its core constructs toward incorporating new determinants, such as trust and ethics, in the future. While the traditional constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions remain relevant, they require refinement to reflect the realities of AI-driven higher education. Thus, bibliometric trends indicate that UTAUT is not only documenting technology adoption but also evolving into a framework that helps redefine technology acceptance in the context of digital transformation.

From the thematic map, the application of the UTAUT model in higher education reveals a dynamic and evolving research landscape. Emerging research trends related to the UTAUT model are likely to include topics such as "ChatGPT" and "artificial intelligence." The growing prominence of these keywords is primarily attributed to the widespread integration of ChatGPT and AI technologies in higher education. As ChatGPT continues to develop, researchers are increasingly examining how these technologies impact educational practices and student learning outcomes (Parker et al., 2024). ChatGPT, which provides personalized learning experiences through natural language processing, enhances student motivation and fosters self-directed learning (Alshahrani, 2023). At the same time, AI technologies not only enhance the sustainability of educational systems but also improve student achievement through instant feedback and personalized instructional support (Rawas, 2024). At the same time, the rise of "ChatGPT" and "AI" as future themes demands a balanced view that considers both opportunities (personalization, rapid feedback) and the unresolved challenges that higher education faces, including academic integrity, data privacy, bias, and transparency. These issues are now central to debates on the responsible use of AI and must be integrated into UTAUT-based models as determinants, such as trust, ethics, and governance (Kemouss & Khaldi, 2025).

Research trends also predict that students will increasingly adopt AI tools, such as ChatGPT, in the future. Therefore, it is crucial to understand the determinants and barriers that affect students' behavioral intentions in using AI tools like ChatGPT (Lai et al., 2024). Recent studies reveal that artificial intelligence does not merely serve as another educational technology but actively challenges the explanatory power of UTAUT's original constructs. For instance, acceptance of AI systems in universities has required the incorporation of new determinants such as algorithmic transparency, ethical concerns, and governance, which extend beyond the classical predictors of performance expectancy and effort expectancy (Ahmed et al., 2025; Kemouss & Khaldi, 2025). Comparative bibliometric reviews indicate that while mobile learning adoption under UTAUT emphasizes usability and accessibility (Alper Aytekin et al., 2022; Granić, 2024), AI adoption in higher education introduces qualitatively different debates surrounding trust, bias, and institutional responsibility. This suggests that AI is

not simply an extension of prior digital tools, but a transformative force that requires UTAUT to evolve into a socio-technical acceptance framework. Our findings demonstrate that UTAUT research is transitioning from validating traditional constructs to integrating cross-disciplinary determinants that capture AI-specific risks and opportunities.

Additionally, educators may require systematic training to effectively integrate these tools into their teaching practices (Parker et al., 2024). Researchers are expected further to explore the applications of these technologies in education, assessing their impact on student learning behaviors and outcomes. Consequently, educators and learners must continually adapt their teaching strategies and learning methods to meet the evolving demands of education, ultimately achieving greater success in learning. Institutions should pair adoption with safeguards (clear AI policies, integrity protocols, data-protection measures, and staff training) to ensure equitable and responsible use (Kemouss & Khaldi, 2025; Parker et al., 2024).

In summary, the bibliometric insights provide concrete recommendations: universities should take note of the 2019 publication surge and prepare for similar "shock-driven" surges (e.g., AI integration) by establishing rapid-response research clusters and funding schemes that support technology adoption studies during critical periods. Similarly, the growing prominence of AI-related keywords in co-occurrence networks highlights the need to embed AI ethics, trust, and transparency into UTAUT-informed teaching policies. Authorship trends also reveal an increasing trend of international collaboration, suggesting that institutions should promote cross-border research networks to accelerate the refinement of UTAUT for globalized higher education, ensuring that pedagogical strategies evolve in parallel with identified bibliometric shifts.

LIMITATION

This study has several limitations. First, the bibliometric analysis relies solely on documents indexed in the Scopus database, potentially excluding relevant studies from other databases—limitations of Bibliometric Tools. While VOSviewer and Biblioshiny offer powerful visualization and network analysis capabilities, they also present certain limitations. For example, VOSviewer relies on co-occurrence frequency thresholds that may underrepresent niche but emerging themes. At the same time, Biblioshiny is constrained by its dependency on the R environment, which may affect computational efficiency when handling large datasets.

Future research could incorporate broader databases, such as Web of Science, to ensure comprehensive coverage of the literature. Secondly, this study proposes future directions but does not provide a detailed thematic exploration of specific trends, such as the ethical implications of AI or the interplay between AI and collaborative learning environments. Future studies should delve deeper into these emerging themes to inform policymakers and educators on how to navigate the evolving technological landscape in education effectively.

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