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Article

Review of the unified theory of acceptance and use of technology (UTAUT) in education: A bibliometric visual analysis based on CiteSpace

Yun Zhou[1,2,*], **Md Gapar Md Johar**[3]

[1] Zhe Jiang College of Construction, Hangzhou 311231, China
[2] Post Graduate Center, Management and Science University, 40100 Shah Alam, Malaysia
[3] Software Engineering and Digital Innovation Center, Management and Science University, 40100 Shah Alam, Malaysia
*** Corresponding author:** Yun Zhou, 321012021070032@pgc.msu.edu.my

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Abstract: This paper conducts a bibliometric visual analysis of the application of the Unified Theory of Acceptance and Use of Technology (UTAUT) in education, using CiteSpace software. Drawing on data from the Web of Science, the study explores research trends and influential works related to UTAUT from 2008 to 2023. It highlights the growing use of educational technologies such as mobile learning and virtual reality tools. The analysis reveals the most cited articles, journals, and key institutions involved in UTAUT research. Furthermore, keyword analysis identifies research hot spots, such as artificial intelligence and behavioral intentions. This study contributes to the understanding of how UTAUT has been used to predict technology adoption in education and provides recommendations for future research directions based on emerging trends in the digital learning environment.

Keywords: UTAUT; education; technology acceptance; technology adoption; CiteSpace

1. Introduction

The swift advancement of computers and information technology has stimulated extensive academic exploration into the acceptance and utilization of information technology, focusing particularly on behavioral intentions and actual usage patterns. The Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003) stands as one of the most frequently referenced frameworks within information systems (IS) research, its influence reaching far beyond the IS domain and encompassing a diverse array of contexts and demographics (Blut et al., 2022). UTAUT has emerged as a leading model widely applied to understand technology adoption, especially within educational environments (Granic, 2022).

Educational technologies such as online learning platforms, mobile learning apps, and virtual reality tools are becoming increasingly prevalent. Existing research has focused on students' and teachers' acceptance and use behaviors of educational technologies (e.g., mobile learning tools). Mobile learning (M-Learning) devices and technologies are the most commonly studied types of technology in education. The Unified Theory of Acceptance and Use of Technology (UTAUT) helps researchers and educators understand how students and teachers are embracing these technologies and predict their usage behavior. However, there are few bibliometric analysis articles available on the application of UTAUT in education.

This paper examines the research correlations and trends of UTAUT within educational settings by conducting a literature review using CiteSpace software and bibliometric analysis. Moreover, it leverages the latest version of CiteSpace to reveal

citation cluster dependencies and trends that were previously inaccessible in bibliometric analyses of UTAUT within the educational domain.

The novelty of this study lies in its choice of the Web of Science as the data source, selected for its recognized academic credibility after a thorough evaluation of multiple databases. This selection process is detailed comprehensively within the paper. The study also highlights the most impactful articles and journals within UTAUT-related educational research.

The structure of the paper unfolds as follows: The methodology used for the review is elaborated in the subsequent section. Following this, section 3 and 4 are dedicated to presenting the findings and discussions, organized around addressing the research questions. Finally, Section 5 offers conclusions and implications for future research on UTAUT in education and it outlines the research limitations.

2. Materials and methods

2.1. Data sources

Data retrieval plays a pivotal role in bibliometric analyses. On the three main databases—Web of Science, Scopus, and Dimensions—Dimensions is distinguished by its broad journal coverage, while Web of Science is noted for its selectivity. Web of Science and Scopus concentrate primarily on life sciences, physical sciences, and technology fields, whereas Dimensions provides wider coverage across social sciences, engineering, and arts and humanities (Singh et al., 2021).

In this study, CiteSpace was selected as the tool for bibliometric analysis due to its robust performance when paired with the Web of Science (WoS) database. During initial econometric analysis trials, both Scopus and Dimensions were evaluated as potential data sources; however, CiteSpace encountered issues and errors when conducting institutional, country, and citation analyses with these sources. Additionally, this paper seeks to identify research hotspots in UTAUT within educational studies and to forecast future trends through bibliometric analysis, which heavily depends on keyword analysis. Testing revealed minimal differences in the keyword analysis outcomes between using WoS alone and using a combination of WoS, Scopus, and Dimensions for trend prediction. Thus, WoS was chosen as the sole data source for this bibliometric analysis.

The search approach incorporated topics linked to the "Unified Theory of Acceptance and Use of Technology" (UTAUT) and education, covering publications from 2008 to 2023. This involved constructing a search string based on the logical formulation: (Topics related to "Unified Theory of Acceptance and Use of Technology") OR (Topics related to UTAUT). Search terms under "Topics related to UTAUT" included "UTAUT" OR "Unified Theory of Acceptance and Use of Technology." For "WOS Categories related to Education," the search conducted on 13 July 2024, returned a total of 208 records.

2.2. Analysis methods

CiteSpace, developed by Professor Chaomei Chen's team at Drexel University, USA, is a software grounded in co-citation analysis theory. It enables the visualization

of the structure, patterns, and distribution of scientific knowledge through knowledge graphs created from extensive literature within a specific research area, making it a valuable tool for visual bibliometric analysis. In this study, CiteSpace was employed to map the authors, publishing institutions, countries, and keywords from the selected articles. It produced co-occurrence networks of authors, institutions, and countries, alongside keyword co-occurrence, clustering, and timeline visualizations. Additionally, CiteSpace highlighted highly cited journals and papers, creating overlay maps of influential and frequently cited studies. This enabled a detailed and scientific examination of the current state, major themes, and emerging trends in UTAUT-related educational research, providing insights into the overall progress in this field.

Graph theory has recently emerged as an advanced scientometric technique for the analysis and visualization of scientific research (Naveed and Anwar, 2022). In this study, CiteSpace v6.1 was used to analyze 208 UTAUT-related documents and their references. Key parameters were set to generate visual knowledge maps and tables, depicting the research status, intellectual foundations, emerging frontiers, and hot topics within UTAUT studies. These parameters encompassed a nearly 16-year time span (2008–2023), with nodes representing authors, countries, keywords, and references, and a visualization network selection based on the g-index or top 50%. CiteSpace calculated several indicators (Qi et al., 2021), including: (1) Modularity value (Q) (>0.3), showing the degree to which a network divides into distinct clusters; (2) Silhouette value (S) (>0.5), reflecting the quality and homogeneity of clusters; and (3) Citation burst (b), indicating a marked increase in citations over specific periods.

3. Results and findings

3.1. The temporal distribution of publications

Figure 1 illustrates the trends in umber of documents according with UTAUT in education by source from 2008 to 2023. The x-axis represents the years from 2008 to 2023, while the y-axis shows the annual number of publications. Several observations can be drawn: First, interest in UTAUT within educational research has shown a clear upward trajectory over the past 15 years. Publications on the topic have steadily increased from 2008 (the earliest year retrieved) to 2023, with a noticeable rise following the onset of the COVID-19 pandemic in 2019. This growth trend can be segmented into four phases: the initial phase from 2008 to 2012, marked by fewer than five articles published annually, indicating an embryonic stage; the second phase from 2013 to 2020, where publication numbers surged to two to four times previous figures, reflecting explosive growth; and the final phase from 2021 to 2023, during which publication volume has notably expanded.

Figure 1. Trends in the annual and cumulative number of publications.

3.2. Co-institution analysis

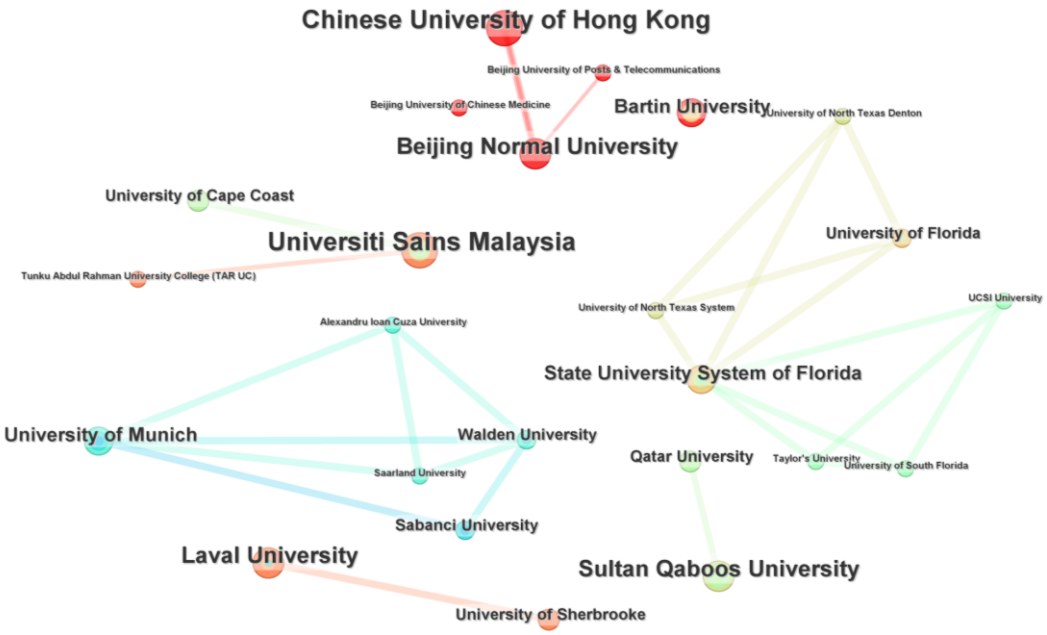

Figure 2. A network map showing institutional collaborations.

To examine the collaborative efforts of various academic institutions in research related to the Unified Theory of Acceptance and Use of Technology (UTAUT) within the field of education. the visualized network diagram obtained using CiteSpace is shown in **Figure 2** which showed the network map showing institutional collaborations. The size of each node indicates the volume of articles published by an institution, while the links between nodes signify collaborative relationships between institutions. Analyzing the nodes and connections, a total of 193 institutions have engaged in UTAUT research within education (N = 193), with 105 instances of collaboration among them (E = 105). The majority of participating institutions are universities and colleges.There are several cooperative group, such as a research group including the Chinese University of Hongkong, Beijing Normal University and Beijing University of Post and Telecommunications; another group consisting of

University of Munich, Alexandru loan Cuza University, Walden University, Sabanci University, and Saarland University. The University Sains Malaysia, State University System of Florida, Sultan Qaboos University, Laval University Played a major role in their own cooperative group.

3.3. Co-citation analysis

Co-citation analysis is a robust method for evaluating the relationships among authors, publications, and journals by creating mapping networks to examine scientific research domains. This approach quantitatively reveals foundational knowledge, research hotspots, and emerging trends.

3.3.1. Journal co-citation analysis

The journal co-citation network sheds light on the influence of individual journals within this knowledge area. Assessing a journals impact enables readers and researchers to swiftly locate relevant information. Using CiteSpace, a visual map of journal co-citation with 205 nodes (N = 205) and 362 links (E = 3,627,844) was constructed, as shown in **Figure 3**. Each node denotes a journal, and the size of the node reflects the co-citation frequency of that journal.

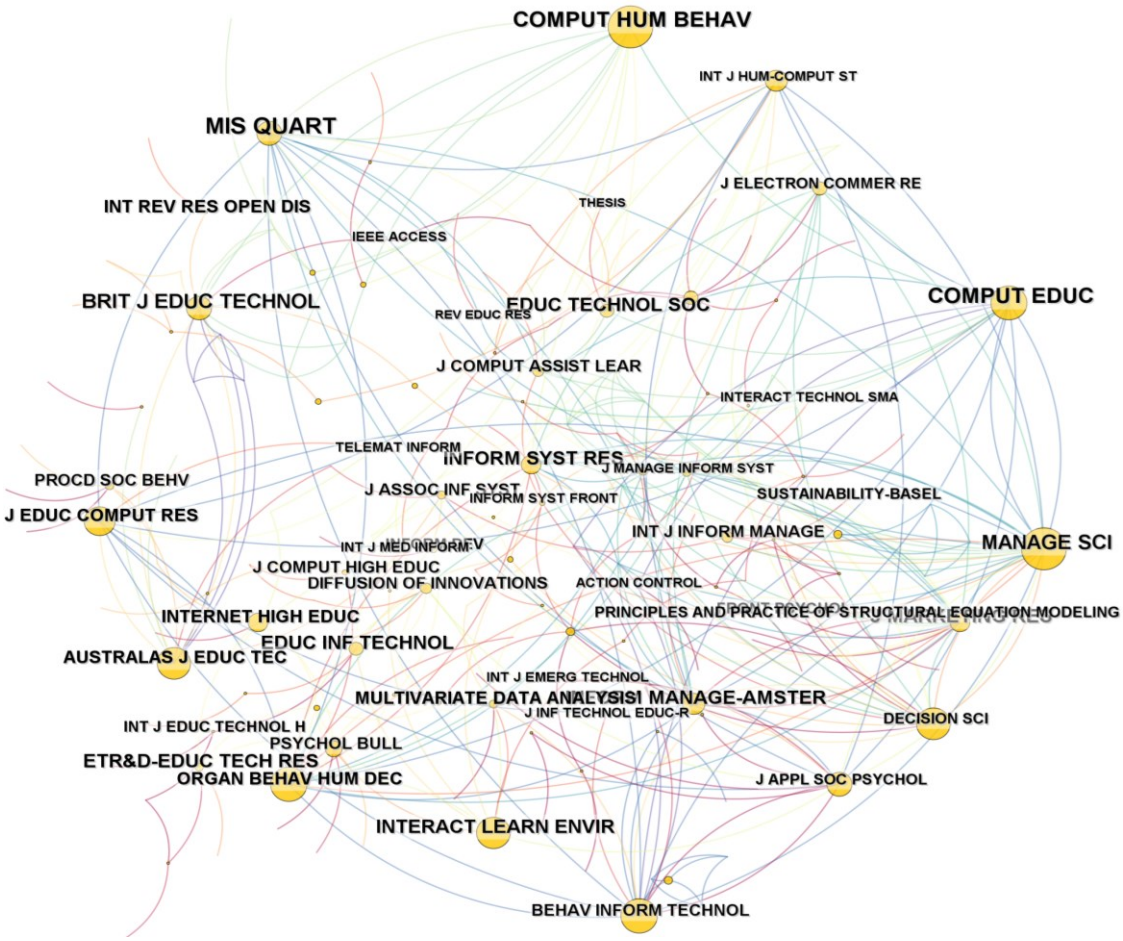

Figure 3. A network map showing journal co-citation.

Table 1 portrays the top 10 most-cited journals in the field of UTAUT in education. “MIS QUART” (206 times) topped the list, followed by “COMPUTERS

and EDUCATION" (161 times), "COMPUTERS IN HUMAN BEHAVIOR" (145 times), etc. Core journals are the most frequently cited, reflecting their publication of more detailed and comprehensive research articles that are regularly referenced by scholars in the field.

Table 1. Top 10 most-cited journals.

Cited journals	Citation count	Year
Mis Quart	206	2008
Computers and education	161	2008
Computers in human behavior	145	2011
British journal of educational technology	104	2008
Management science	92	2008
Journal of marketing research	82	2010
Information and management	78	2009
Education and information technologies	78	2016
Information systems research	76	2010
Educational technology and society	72	2012

3.3.2. Literature co-citation analysis

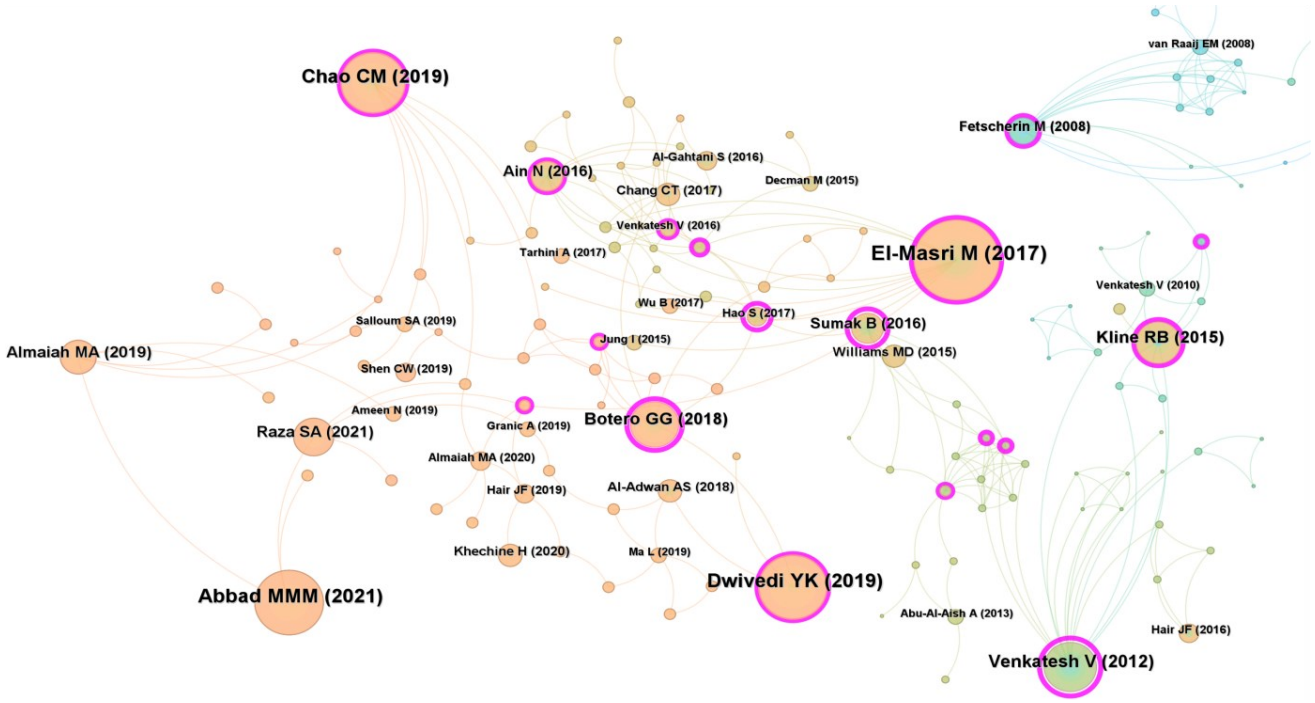

Figure 4. A network map showing literature co-citation.

Research articles and publications serve as fundamental components of a scientific literature database. Literature co-citation analysis provides a valuable and efficient method for examining the knowledge foundation and progression of a specific research domain. By analyzing co-cited works, it becomes possible to identify significant academic contributions within the field. Using CiteSpace for this purpose, a co-citation visualization network was constructed, consisting of 179 nodes ($N = 179$)

and 314 links (E = 314), as shown in **Figure 4**.

Table 2 presents the ten most influential articles in UTAUT research within the education field, ranked by citation count. The table details the first author's name, citation frequency, publication year, and DOI. The study by El-Masri and Tarhini (2017) is the most cited, with 21 citations, followed by the works of Yogesh K. Dwivedi et al., and Muneer M. M. Abbad, each with 17 citations.

Table 2. Top 10 most-cited literature studies.

Cited literature	Citations count	Year	DOI
El-Masri M and Tarhini A	21	2017	10.1007/s11423-016-9508-8
Dwivedi YK et al.	17	2019	10.1007/s10796-017-9774-y
Abbad MMM	17	2021	10.1007/s10639-021-10573-5
Chao CM	16	2019	10.3389/fpsyg.2019.01652
Venkatesh V et al.	13	2012	10.2307/41410412
Botero GG	12	2018	10.1007/s12528-018-9177-1
Kline RB	11	2015	10.25336/csp29418
Raza SA et al.	10	2021	10.1177/0735633120960421
Almaiah MA et al.	9	2019	10.1109/ACCESS.2019.2957206
Sumak B and Sorgo A	8	2016	10.1016/j.chb.2016.07.037

El-Masri and Tarhini (2017) investigated the key factors that may facilitate or obstruct the adoption of e-learning systems by university students in both developing (Qatar) and developed (USA) countries. They applied an extended version of the Unified Theory of Acceptances and Use of Technology (UTAUT2), incorporating Trust as an external variable. Data were collected through an online survey involving 833 university students, with one cohort from a university in Qatar and the other from a university in the USA. Structural equation modeling was employed as the primary method of analysis. The results revealed that performance expectancy, hedonic motivation, habit, and trust were significant predictors of behavioral intention (BI) in both groups. However, the influence of price value on BI was found to be insignificant. Furthermore, the study showed that effort expectancy and social influence positively impacted the adoption of e-learning systems in developing countries, but had no such effect in developed countries. Additionally, facilitating conditions were found to significantly promote e-learning adoption in developed countries, a factor that was not significant in developing countries.

Dwivedi et al. (2019), through a critical review of the UTAUT, analyzed 1600 observations from 21 relationships derived from 162 previous studies on IS/IT acceptance and usage. The findings revealed that attitude played a central role in shaping both behavioral intentions and usage behaviors, partially mediating the effects of exogenous constructs on behavioral intentions, while also exerting a direct influence on usage behaviors.

Abbad (2021) investigated various factors influencing the acceptance of information systems through multiple adoption models. In this study, the UTAUT, which integrates determinants from eight distinct models, was applied to analyze students' intentions and actual use of Moodle, an e-learning platform at Hashemite

University, a public institution in Jordan. The research focused on four key determinants of intention and usage: performance expectancy, effort expectancy, social influence, and facilitating conditions. Data from 370 undergraduate students were collected and analyzed using structural equation modeling techniques. The results indicated that performance expectancy and effort expectancy had a significant effect on students' behavioral intentions to use Moodle, while social influence did not. Moreover, the findings confirmed that both behavioral intentions and facilitating conditions directly influenced the students' use of Moodle.

Chao (2019) proposed and empirically tested a model to identify the factors influencing students' behavioral intentions regarding mobile learning (m-learning). Utilizing the UTAUT framework, the study incorporated perceived enjoyment, mobile self-efficacy, satisfaction, trust, and perceived risk as moderating variables. The research examined m-learning behavioral intentions from a consumer perspective. A cross-sectional study was conducted, grounded in various technology acceptance theories, with data gathered through an online survey from 1562 participants. The data were then analyzed using structural equation modeling techniques.The results indicated that (1) behavioral intention was significantly and positively influenced by satisfaction, trust, performance expectancy, and effort expectancy; (2) perceived enjoyment, performance expectancy, and effort expectancy positively correlated with behavioral intention; (3) mobile self-efficacy had a significant positive impact on perceived enjoyment; and (4) perceived risk negatively moderated the relationship between performance expectancy and behavioral intention.

Venkatesh et al. (2012) expanded the UTAUT to explore technology acceptance and usage in a consumer context. The revised UTAUT2 model introduces three additional constructs: hedonic motivation, price value, and habit. It also accounts for individual differences, including age, gender, and experience, as moderators of the influence these constructs have on behavioral intention and technology use. The model was validated using data from a two-phase online survey of 1512 mobile internet users, with technology usage data gathered four months following the initial survey.Compared to UTAUT, UTAUT2 significantly increased the explained variance in behavioral intention (from 56% to 74%) and technology use (from 40% to 52%).

Botero (2018) conducted research on mobile learning, revealing that students primarily perceive mobile devices as tools for communication and entertainment. A key factor in successfully implementing mobile learning is the initial evaluation of students' acceptance of these devices for educational use. The study adapts and extends the UTAUT model to assess the factors influencing behavioral intentions and actual use of Mobile Assisted Language Learning (MALL). Data were gathered and analyzed using structural equation modeling techniques.The results indicate that performance expectancy, social influence, and facilitating conditions significantly affect students' attitudes toward using MALL, with attitude being the most significant factor influencing behavioral intention. The model also demonstrates that behavioral intention impacts MALL usage. The study concludes that students' acceptance is crucial for the successful adoption of MALL.

Raza et al. (2021) explored the UTAUT through the expansion of the model in in the time of COVID-19. The study examined the impact of social isolation and the moderating effect of COVID-19-related fear on students' behavioral intention and

usage behavior of a Learning Management System (LMS). Data were analyzed using Partial Least Squares (PLS) and Structural Equation Modeling (SEM) techniques. The findings revealed a positive relationship between Performance Expectancy, Effort Expectancy, Social Influence, Social Isolation, and Behavioral Intention toward LMS, as well as between Behavioral Intention and LMS Use Behavior. Additionally, the moderation analysis indicated that COVID-19-related fear moderated the relationship between Performance Expectancy and Social Influence with Behavioral Intention toward LMS. These results suggested the necessity of enhancing the LMS experience to boost its Behavioral Intention among students.

Sumak and Sorgo (2016) explored the acceptance and use of interactive whiteboards (IWBs) among teachers. This study aimed to extend the UTAUT model by introducing a new moderator variable—user type—to examine differences in the UTAUT determinants between pre-adopters and post-adopters of IWBs. The findings revealed that social influence had a greater effect on behavioral intentions, while performance expectancy had a stronger influence on attitudes toward using IWBs. Additionally, attitudes toward using IWBs differed between users, affecting their potential use of the technology. Furthermore, facilitating conditions were found to have a more significant impact on the actual use of IWBs, and behavioral intention was a stronger predictor of actual use among post-adopters compared to pre-adopters.

3.3. Author co-citation analysis

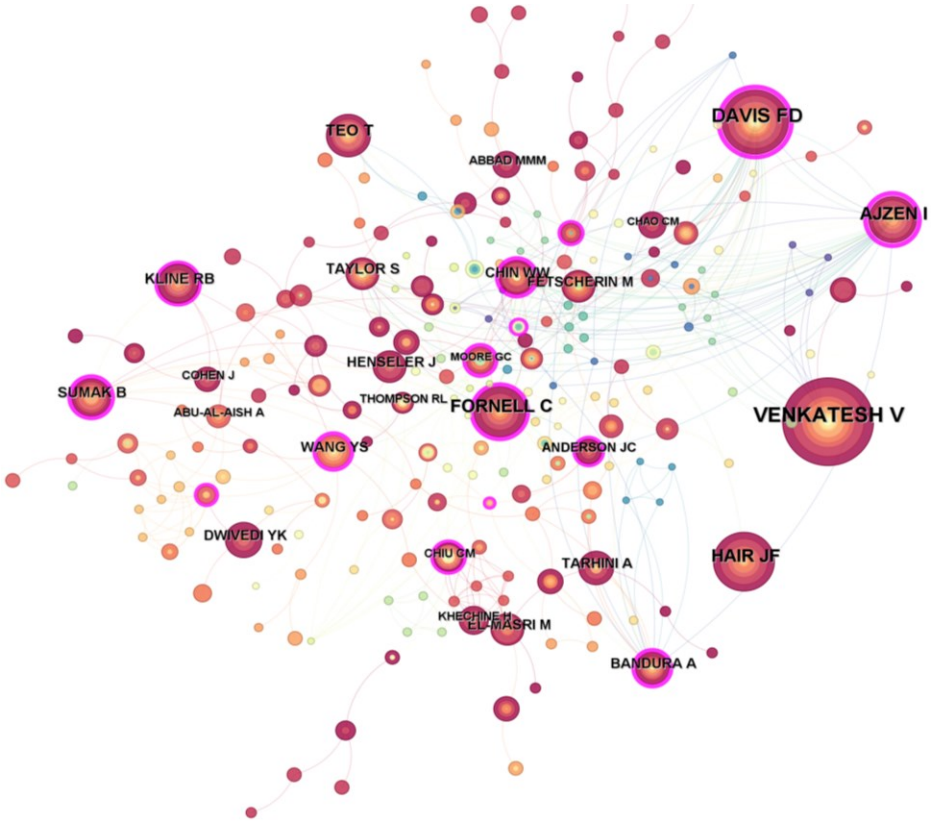

Figure 5. A network map showing authors co-citation.

Author co-citation analysis is an effective method for identifying the most influential and active scholars within a specific research domain, as well as for

examining the distribution of the most frequently cited authors in that field. This analysis was conducted on UTAUT research in education, with the resulting network presented in **Figure 5**. In this network, each node represents an author, with the node size corresponding to the frequency of co-citations, while the denser lines between nodes indicate a stronger relationship between the most frequently co-cited authors.

Additionally, **Table 3** lists the top 10 most cited authors, with Venkatesh V leading with 205 co-citations, followed by Davis FD with 122 and Hair JF with 86.

Table 3. Top 10 most-cited authors.

Author	Citations count	Year
Venkatesh V	205	2008
Davis FD	122	2009
Hair JF	86	2013
Ajzen I	81	2008
Fornell C	78	2010
Teo T	54	2010
Sumak B	37	2017
Kline RB	36	2013
Taylor S	34	2010
Bandura A	33	2009

3.4. Keyword co-occurrence analysis

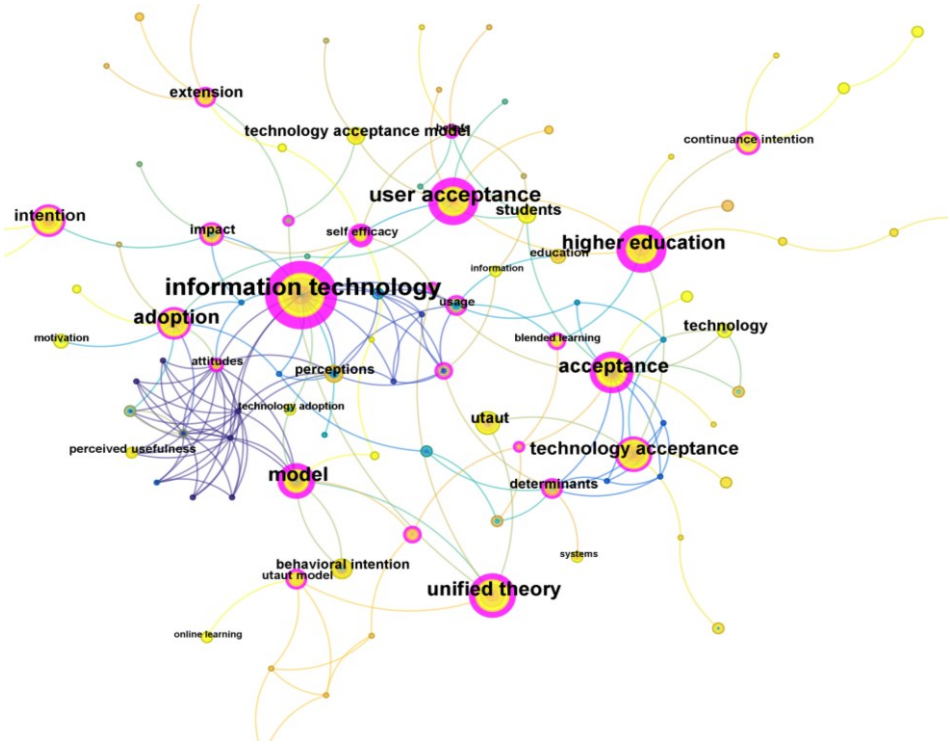

Figure 6. A network map showing keyword co-occurrence.

Keywords encapsulate key information about the research topic and the central themes of the article. Additionally, the popularity of different keywords varied over

time, and analyzing their evolution provided insights into research trends. By studying the temporal shifts in the centrality and frequency of co-occurring keywords, we identified the most significant research areas within the UTAUT literature. This analysis produced a network graph featuring 100 nodes and 184 links, as shown in **Figure 6**.

The **Table 4** of network map revealed that the most frequently used keyword is "information technology" (126 times).The other top ten keywords were "user acceptance", "unified theory", "adoption", "acceptance" "model", "higher education", "technology acceptance", "intention" and "UTAUT" reflecting UTAUT Research in education.

Table 4. Top 10 co-occurrence keywords.

Frequency	Year	Key words
126	2008	Information technology
74	2013	User acceptance
60	2013	Unified theory
58	2009	Adoption
56	2008	Acceptance
52	2008	Model
50	2013	Higher education
46	2013	Technology acceptance
31	2015	Intention
23	2018	Utaut

The keyword frequency table provided offers a detailed overview of the most common terms associated with the Unified Theory of Acceptance and Use of Technology (UTAUT) in the context of education. Analyzing the table, which spans from 2008 to 2023, reveals several trends and focal points in research during this period.

The term "information technology" (IT) standed out with the highest frequency, particularly in 2008. This indicated a strong focus on IT within the early studies applying UTAUT, reflecting the increasing integration of technology in educational environments. Researchers likely emphasized understanding how IT could be effectively accepted and utilized within educational settings.

The prominence of "user acceptance" in 2013 signaled a significant research interest in the factors influencing the acceptance of new technologies by users, particularly educators and students. This focus aligned with the core objective of UTAUT, which is to explain and predict user behavior towards technology adoption.

The frequency of "unified theory" in the same year suggests a consolidation of UTAUT as a theoretical framework in educational research. By 2013, the theory had become a widely recognized tool for analyzing technology acceptance, reflecting its applicability across various educational contexts.

The "adoption" peaked in 2009, highlighting an early emphasis on the processes through which educational institutions and individuals adopted new technologies. This early focused on adoption is crucial, as it seted the foundation for understanding the

subsequent phases of technology integration in education.

Closely related to user acceptance, "acceptance" in 2008 further underscored the initial efforts to understand the conditions under which educational technologies were accepted by users. The slight difference in frequency between "acceptance" and "user acceptance" may reflect variations in the scope or focus of studies.

The term of "model" in 2008 suggested a focus on the theoretical and methodological aspects of UTAUT. Researchers were likely engaged in refining or testing the UTAUT model's applicability to different educational scenarios, contributing to its broader acceptance and use.

"Higher education" became prominent in 2013, indicating a growing interest in applying UTAUT within universities and colleges. This shift suggested that by this time, higher education institutions were increasingly exploring how to leverage technology for teaching, learning, and administrative purposes.

The term "technology acceptance" complemented the focus on user acceptance, providing a broader view of how various stakeholders in education, including administrators and policymakers, perceived and embraced technological advancements.

The appearance of "intention" in 2015 pointed to a deeper exploration of the precursors to technology adoption. Researchers were likely examining the intentions behind adopting or rejecting technology, which was a critical element of the UTAUT model.

"UTAUT" became more frequently used in 2018. This suggested a maturing of the field, where UTAUT is not only applied but also critically evaluated and discussed as a standalone concept in educational technology research.

Overall, the keyword frequency analysis highlights the trajectory of UTAUT research in education, from broad acceptance and adoption studies to more nuanced explorations of the theory's application in specific educational contexts. This trend suggests a progressive maturation of UTAUT as a key framework for understanding technology acceptance in education, with increasing attention to both theoretical and practical implications in the field.

Figure 7 reflects the top 8 keywords with the highest burst intensity. The keyword "perceptions" experienced a significant citation burst starting in 2008 and lasting until 2013. This period aligns with the early adoption phase of UTAUT in educational research, where scholars were keen on understanding how individuals perceive the integration of technology within educational settings. The strong burst indicates that perceptions were a central concern, as they directly influence the acceptance and use of technology by educators and students.

"Usage" shows a citation burst starting in 2009 and extending over a decade until 2019. This extended burst period reflects a sustained interest in studying how educational technologies are used in practice. The strength and duration of this burst suggest that understanding the actual use of technology, beyond mere acceptance, became a critical area of inquiry, emphasizing the practical application of UTAUT in educational contexts.

The keyword "model" had the strongest citation burst, beginning in 2014 and lasting until 2018. This reflects a period where the UTAUT model itself became a focal point of analysis, possibly due to its widespread adoption and the need for further

refinement or adaptation to various educational environments. The strong citation burst indicates that researchers were heavily engaged in discussing, validating, and expanding the theoretical model during this period.

Figure 7. 8 keywords with the strongest citation bursts.

The "technology" saw a burst from 2015 to 2018, underscoring a period where the discussion around educational technology gained momentum. The focus during this time likely involved exploring various types of technologies and their implications for education, as well as how UTAUT could be applied to these emerging tools and platforms.

"Acceptance" had a notable citation burst in 2015–2016. This brief yet strong burst indicates a concentrated effort to understand the conditions under which technology is accepted within educational settings. During this period, research may have focused on identifying factors that influence acceptance, a core component of the UTAUT model, highlighting the model's relevance in addressing practical challenges in technology adoption.

The keyword "behavioral intention" experienced a citation burst from 2017 to 2018. Behavioral intention is a key predictor of technology use in the UTAUT model, and the burst suggests that researchers were increasingly interested in exploring the intentions that drive individuals to adopt or reject educational technologies. This focus aligns with a deeper exploration of the psychological and social factors influencing technology use.

The term "higher education" saw a citation burst in 2021, indicating a recent surge of interest in applying UTAUT specifically within the context of universities and colleges. This could be linked to the rapid digitization of higher education, particularly in response to global events such as the COVID-19 pandemic, which necessitated a shift to online learning and brought issues of technology acceptance to the forefront.

The "UTAUT model" itself experienced a citation burst starting in 2021 and continuing into 2023. This indicates a renewed interest in the model, possibly driven by its applicability to new challenges and contexts in education, such as remote learning and digital transformation. The ongoing burst suggests that UTAUT remains a vital framework for understanding technology adoption in education and that researchers continue to explore its relevance and adaptability.

The citation bursts indicate that while the foundational aspects of UTAUT remain central to the discourse, there is a continuous evolution in how the model is applied

and studied, reflecting the dynamic nature of educational technology research.

3.5. Keyword cluster analysis

Cluster analysis organizes the entire knowledge domain of UTAUT in education by grouping co-occurring keywords or co-cited literature. It categorizes the gathered bibliometric data into distinct clusters by extracting noun terms from the title, abstract, or keywords of a document. A cluster analysis based on co-cited literature was conducted for UTAUT in education research using CiteSpace, as illustrated in **Figure 8**. The analysis identified a total of 10 clusters through the application of the LLR algorithm.

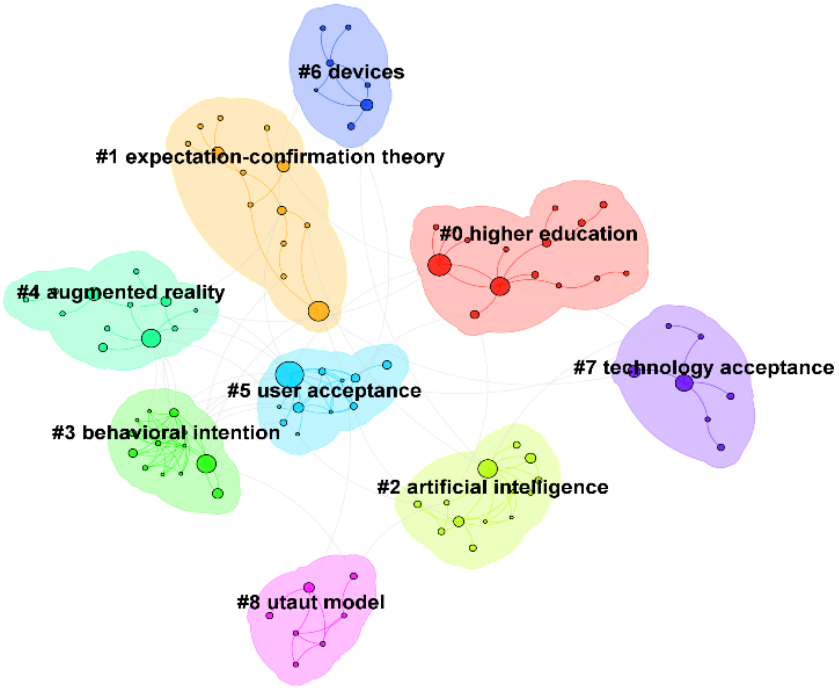

Figure 8. Clustering map of keyword co-occurrence.

The characteristics of the clusters, including their LLR-based title keywords, size, and silhouette index, are provided in **Table 5**. The silhouette index was used to assess the homogeneity of the cluster members, with higher values signifying greater similarity among the members. As indicated in **Table 5**, the silhouette index for all clusters exceeded 0.89, suggesting that the clustering was both homogeneous and highly reliable. The three largest clusters, identified by the keywords "higher education," "expectation-confirmation theory," and "artificial intelligence," suggested that these topics had been extensively studied by scholars. In contrast, the smallest cluster was identified by the keyword "UTAUT model."

Table 5. Clustering of keyword co-occurrence.

Cluster ID	Cluster label (LLR)	Size	Silhouette
#0	higher education	15	0.89
#1	expectation-confirmation theory	13	0.713
#2	artificial intelligence	13	0.929

Table 5. (*Continued*).

Cluster ID	Cluster label (LLR)	Size	Silhouette
#3	behavior intention	13	0.964
#4	augmented reality	12	0.903
#5	user acceptance	11	0.778
#6	devices	7	0.952
#7	technology acceptance	7	0.9

4. Discussion

The findings of this bibliometric analysis using CiteSpace offer several insights into the evolving research trends in the application of the Unified Theory of Acceptance and Use of Technology (UTAUT) within educational contexts. The significant increase in UTAUT-related publications post-2019, particularly following the COVID-19 pandemic, highlights the growing importance of educational technologies and their adoption across the globe. The four distinct stages of growth in publication volume, especially the exponential increase during 2021–2023, suggest a heightened interest in understanding the factors influencing technology acceptance in a rapidly digitizing educational environment.

One notable observation from the analysis is the prominence of collaboration among universities worldwide, particularly institutions from China, the United States, and Europe. The strong institutional collaborations, visualized through co-institution analysis, underscore the global nature of UTAUT research in education. This international cooperation reflects a shared global challenge in technology integration within educational systems, driven by the need for innovative solutions in the wake of technological advancements and educational reforms.

The co-citation analysis further highlights the intellectual foundation of UTAUT research, with journals such as MIS Quarterly, Computers and Education, and Computers in Human Behavior emerging as key contributors to the literature. These journals' high citation frequencies point to their influential role in shaping the academic discourse on technology adoption, particularly in educational settings.

In terms of key literature, the works of Venkatesh et al. (2012) and El-Masri and Tarhini (2017) have been pivotal in extending the UTAUT model and applying it to new educational contexts, such as e-learning systems and mobile-assisted learning. The adaptation of UTAUT to different technological applications and contexts highlights the theory's versatility and its ability to address a range of educational challenges.

The keyword co-occurrence analysis revealed the most frequently researched areas, such as "information technology", "user acceptance", and "higher education". The rise in prominence of keywords like "behavioral intention" and "technology acceptance" suggests that recent research has focused on not only understanding the initial acceptance of technology but also the deeper behavioral intentions that drive long-term usage. The burst in keyword citations for terms like "higher education" and "UTAUT model" in 2021–2023 reflects the growing need to adapt these theoretical frameworks to address the unique challenges of higher education in a post-pandemic world.

Finally, the cluster analysis identified key areas of research such as higher education, expectation-confirmation theory, and artificial intelligence. These clusters point to the diverse range of topics that are increasingly being linked with UTAUT, particularly as educational institutions explore new technologies like artificial intelligence and augmented reality to enhance teaching and learning experiences.

5. Conclusion

This study provides a comprehensive bibliometric analysis of UTAUT in educational research, uncovering important trends, key contributors, and potential future directions. The findings demonstrate that UTAUT remains a critical theoretical framework for understanding technology adoption, with its application expanding into various areas of education, especially in response to the increasing reliance on digital tools post-COVID-19.

Several key conclusions can be drawn from this analysis:

1) Growth in UTAUT Research: There has been a significant rise in publications related to UTAUT in education, particularly since 2019. This increase can largely be attributed to the global shift towards digital learning tools during the COVID-19 pandemic.
2) Global Collaboration: Research on UTAUT in education is highly collaborative, with numerous international institutions contributing to the development of this field. This reflects the global nature of educational technology challenges and the shared effort to explore effective adoption strategies.
3) Core Influencers: A small number of highly influential journals and authors continue to shape the UTAUT literature, with the work of Venkatesh et al. remaining central to the discourse on technology acceptance. These key contributions are critical in advancing our understanding of technology use in education.
4) Research Hotspots and Future Directions: The emergence of new research clusters such as artificial intelligence, augmented reality, and higher education suggests that future UTAUT research will likely focus on how these technologies are integrated into educational settings. As educational technologies continue to evolve, there will be a growing need to understand how models like UTAUT can be adapted to new technological and pedagogical innovations.

In conclusion, the Unified Theory of Acceptance and Use of Technology remains an essential tool for researchers aiming to understand and predict the behavior of students and educators toward new technologies. As digital transformation continues to accelerate in the education sector, UTAUT will play a crucial role in guiding future research and informing educational practice.

A constraint of this study lies in its reliance solely on the “Web of Science” databases for data analysis. The study’s robustness could be further augmented by incorporating additional databases. Furthermore, the volume of publications analyzed is another factor; a larger number of publications would likely yield more significant and insightful findings. Consequently, future investigations in this domain hold the potential to provide valuable contributions.

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