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Pulication Trends in Using Technology Acceptance Model to Study Higher Education Online Learning

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Abstract

This study conducts a comprehensive review of the use of the Technology Acceptance Model (TAM) in the field of online learning, with a focus on student satisfaction in higher education. A bibliometric analysis was performed using data collected from the Web of Science (WoS) core collection, comprising 377 publications from 2006 to 2024. The results indicate that TAM has been widely integrated with other theoretical models, such as the Theory of Planned Behavior (TPB), to understand the factors influencing e-learning acceptance. External variables, including cultural, social, and economic factors, have also been considered to explore their effects on e-learning adoption. Key themes identified in the research include perceived usefulness, perceived ease of use, self-efficacy, and learner engagement. The study highlights recent trends in TAM-related research, showing a significant increase in the use of keywords such as “technology adoption” and “blended learning” since 2021. The findings provide valuable insights for future research directions, including deeper exploration of psychological and emotional factors influencing e-learning acceptance and differences across cultural contexts.

Keywords: *T*echnology Acceptance Model, Online Learning, Student Satisfaction, Higher Education, Perceived Usefulness, E-learning Adoption

1. Introduction

With the rapid development of information technology, online learning has gradually become a significant branch in the field of education (Nguyen et al., 2020). It leverages digital technologies to provide learners with flexible and convenient ways of learning. Particularly in the context of the global pandemic, online learning has demonstrated its irreplaceable value (Alyoussef, 2023). However, although online learning offers numerous advantages, its acceptance and effectiveness remain key concerns for both academics and practitioners (Ahmad et al., 2023).

Previous research has extensively explored the acceptance of online learning. Among these studies, the Technology Acceptance Model (TAM) has been widely applied to assess users' willingness and attitudes toward adopting online learning technologies (Granić, 2022). Furthermore, some researchers have integrated external variables and other theoretical models, such as the Theory of Planned Behavior, to further investigate the factors influencing the acceptance of online learning (Chahal & Rani, 2022; Elnagar et al., 2022; Zhou et al., 2022). These studies have not only expanded the TAM by incorporating additional factors such as personal innovativeness, social influence, and self-efficacy, but have also conducted empirical analyses across different cultural contexts and educational settings.

It is noteworthy that in recent years, with the application of advanced technologies such as artificial intelligence and big data, online learning platforms have continuously innovated and evolved. Consequently, new learning models, such as AI-driven online learning and interactive video-based learning, have increasingly gained popularity among learners (Saqr et al., 2023; Bahiyah, 2023). These models have also demonstrated significant potential in improving learning outcomes, enhancing learner engagement, and increasing overall satisfaction.

2. Literature Review

2.1 Technology Acceptance in Online Learning

Currently, online learning faces challenges such as improving the acceptance among students and teachers, and optimizing the learning experience (Sudha, 2022; Zhang & Chang, 2022). In a 2022 study, Khan et al. explored the practical potential of self-directed learning in the implementation of online education. This study employed quantitative techniques and questionnaire design, and the results revealed that participants held clear views on the potential of self-directed learning. On the other hand, the study by Chahal and Rani (2022) focused on the factors influencing students' behavioral intentions and actual usage of online learning. Through an online survey of higher education students in India, the researchers validated an explanatory structural model, introducing three external variables, and the results explained 56.2% of the variance in actual usage.

Kusumawan and Marpanaji's (2022) study reported on the use of an online portal for learning by both students and teachers. The findings indicated that self-efficacy in online learning, complexity, and motivational factors influenced students' use of the portal. Similarly, the research by Szymkowiak and Jeganathan (2022) investigated the acceptance of peer-to-peer (P2P) online learning among 417 Indian students, revealing that perceived ease of use was positively correlated with perceived usefulness and students' attitudes toward P2P online learning.

In the study by Al Hafidz (2022), the researcher employed an extended Technology Acceptance Model (TAM) to determine university students' acceptance of e-learning applications. The findings revealed that lecturer characteristics and content quality significantly influenced students' perceived usefulness of the e-learning applications. Similarly, the study by Akın et al. (2022) focused on the factors affecting university students' acceptance of e-learning, particularly during the COVID-19 pandemic. It was found that compatibility was strongly related to both perceived ease of use and perceived usefulness. Furthermore, Rafique et al. (2023) investigated the key factors influencing the acceptance of e-learning systems in schools. Their results showed that self-efficacy had a significant direct impact on perceived ease of use, and training had a substantial influence on the two core constructs of the Technology Acceptance Model.

2.2 Research on The Influencing Factors of Online Learning

When comparing these studies, it becomes clear that all emphasize the impact of perceived ease of use and perceived usefulness on the acceptance of e-learning. However, many factors influence students' acceptance and use of e-learning. In the study by Nedeljković and Petrović (2022), key factors influencing students' intention to use e-learning and predictors of satisfaction with online teaching were explored. The study found that course design significantly affected the perceived usefulness, ease of use, and quality of e-learning, while perceived usefulness and quality in online teaching were the main drivers of student satisfaction. Meanwhile, Kamouna et al. (2022) investigated the changes in ophthalmology continuing education and training during the COVID-19 pandemic, as well as the advancements in digitalization. The results showed that most participants considered online training platforms as highly suitable alternatives to face-to-face activities, with no overall decline in training activities.

The study by Bailey et al. (2022) utilized the Technology Acceptance Model to explore how the Zoom video conferencing platform influences learning outcomes. The findings revealed that Zoom's perceived ease of use (PEoU) strongly affected perceived usefulness (PU) and actual usage. Moreover, while PU predicted students' intention to use Zoom in the future, it did not influence their perceived learning outcomes. In contrast, the research by Astari et al. (2022) combined Self-Determination Theory with TAM, focusing on evaluating the effectiveness of e-learning through Zoom. Their study

found that perceived ease of use, perceived usefulness, and the intention to use Zoom significantly impacted the effectiveness of e-learning.

Some researchers have also employed latent transition analysis to examine the categories of shifts in students' learning engagement and their influencing factors. Their findings provided empirical evidence for the effectiveness of policy implementation (Yang & Zhang, 2023). Similarly, Tian et al. (2023) combined the Technology Acceptance Model and Expectation Confirmation Theory to explore how factors such as perceived usefulness, perceived interactivity, and ease of use significantly influence user satisfaction on online education platforms. However, they concluded that the impact of word-of-mouth was not significant.

2.3Research on the influencing factors of online learning acceptance in higher education

In today's higher education landscape, where online learning has become a key technological tool, numerous studies have explored and extended the factors influencing students' online learning based on the Technology Acceptance Model (TAM). Al-Bashayreh et al. (2022) and Alyoussef (2023) found that, in addition to perceived usefulness and ease of use, perceived enjoyment plays a crucial role in determining the acceptance of online learning among higher education students. Furthermore, they emphasized the need to consider task-technology fit and information system success factors. Similarly, Chahal and Rani (2022) tested an explanatory structural model of technology acceptance by introducing personal innovativeness, social factors, and self-efficacy as external variables to the TAM, successfully demonstrating that these variables contribute to behavioral intention and actual usage.

Rajeb et al. (2022) primarily focused on external support and found that institutional factors such as technological adequacy, teacher efficiency, and technical support play a significant role in students' acceptance of online learning. These factors are especially crucial for students in developing countries. This view is further supported by Persada et al. (2022), who demonstrated that the acceptance of online learning is influenced by teacher characteristics, technological innovation, and the quality of learning systems. Additionally, Zhou et al. (2022) extended the Technology Acceptance Model by incorporating additional external and perceived variables. Their findings indicated that external factors such as online course design, perceived system quality, and perceived enjoyment, along with the added perceived variable of perceived interactivity, are effective predictors of learners' willingness to use educational platforms.

The aforementioned studies provide valuable insights for higher education institutions, offering a deeper understanding of how to enhance the acceptance and usage of online learning in higher education. These findings serve as a useful reference for future research and practice in this field. Therefore, the present study builds not only on existing research concerning online learning satisfaction

but also offers a more focused analysis of the factors influencing student satisfaction with online learning in higher education. By identifying key areas of interest, citation peaks, and emerging interdisciplinary trends, this study aims to clarify the current state of the field and its future directions.

3. Methodology

A bibliometric study was conducted to evaluate publication trends and gain insights into research on "Online Learning," "Student Satisfaction," "Higher Education," and the "Technology Acceptance Model." In terms of database selection, the Web of Science (WoS) core collection was chosen for data collection due to its focus on high-impact journals and its strict selection criteria, which ensure that the data quality and citation analysis are likely to be more reliable and authoritative. On September 13, 2024, an "All Fields" search was performed in WoS using the terms "Online Learning," "Student Satisfaction," "Higher Education," with a micro topic limitation of "Technology Acceptance Model." A total of 377 valid documents were identified. These 377 documents received a total of 6,748 citations, with an average of 17.9 citations per paper. As shown in Figure 1, although interest in this field remains stable, the growth in recent publications has slowed.

The 377 documents were analyzed using the Bibliometrix software package (http://www.bibliometrix.org/), an R tool designed for scientific mapping. Table 1 lists the key bibliometric data collected, which includes 316 articles, 55 proceeding papers, 5 book chapters, and 1 data paper. To provide a more comprehensive understanding of how the Technology Acceptance Model has been studied in the context of online learning, particularly in higher education, these 377 documents were subjected to qualitative analysis. The following sections will discuss the results of both the quantitative and qualitative analyses in detail.

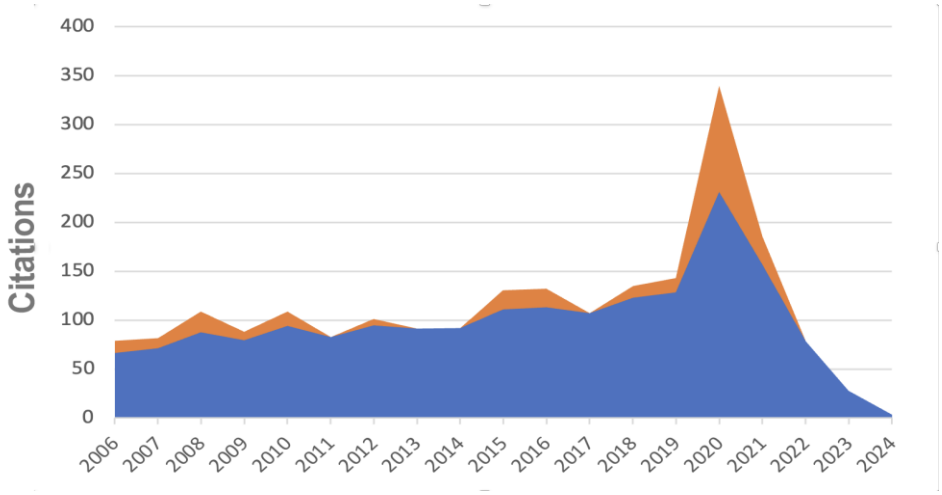

Figure 1 Publication trends in Using Technology Acceptance Model to Study Higher Education Online Learning research field from 2006 to 2024 (orange dotted line: the prediction trends, blue line: the original trends).

Table 1 Summary of the Main Information of Collected Bibliometric Data

Description	Results
Period	2006—2024
Documents	377
Annual Growth Rate %	22.03
Average citations per document	17.9
References	15519
Keywords Plus (ID)	496
Author's Keywords (DE)	1126
Sources (Journals, Books, etc)	208
Authors	1189
International co-authorships %	26.79
Enriched Cited Reference	109

4. Quantitative Analysis

4.1 Analysis of Publication Years

Figure 2 illustrates the annual number of scientific publications from 2006 to 2024. As shown in the figure, the volume of published articles remained relatively low with modest growth between 2006 and 2018. However, a significant surge occurred in 2019 and 2021, with the number of publications doubling compared to the previous years. The peak was reached in 2022, with 86 publications. Although there was a slight decline in the number of publications in 2023 and 2024, research in this field continues to garner substantial attention.

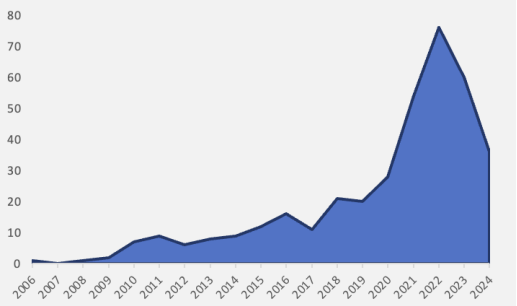

Figure 2 Annual scientific production of exosomes nanoparticles for cancer detection research field within 2008 to 2018 period.

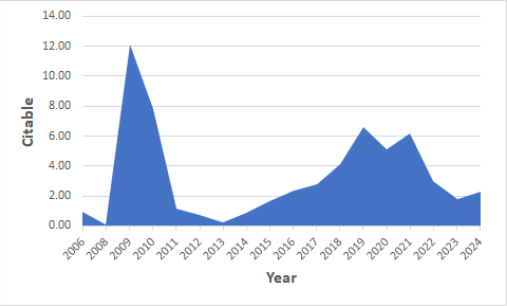

Figure 3 Average article citations per year of Using Technology Acceptance Model to Study Higher Education Online Learning research field within 2008 to 2018 period.

Figure 3 displays the average number of citations per article from 2006 to 2024. According to the trend, articles published in 2009 achieved the highest average number of annual citations, reaching approximately 12 citations. Publications from 2019 and 2021 saw an average of nearly 4 citations per year. However, in the subsequent years, both the number of published articles and their average citation rates declined, reflecting a decrease in academic impact during those years.

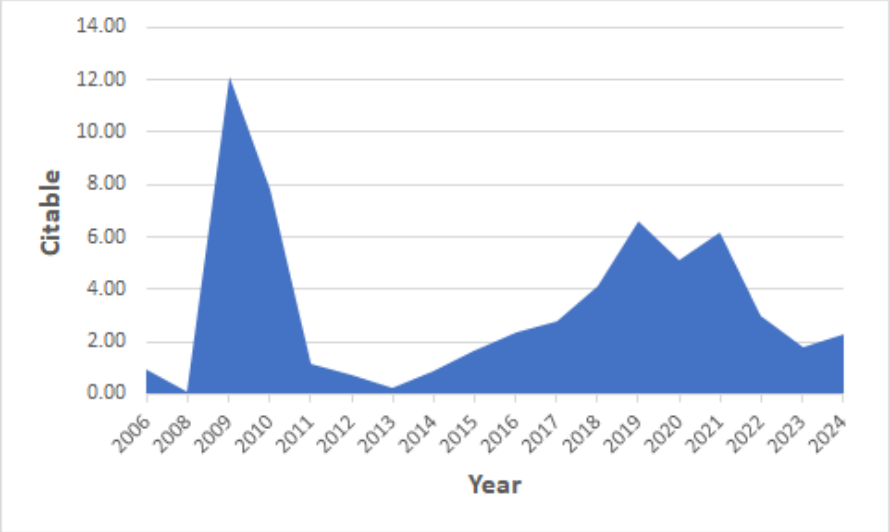

Figure 3 Average article citations per year of Using Technology Acceptance Model to Study Higher Education Online Learning research field within 2008 to 2018 period.

Figure 4 showcases the most globally cited publications, highlighting their significant influence in the study of online learning in higher education using the Technology Acceptance Model. Ranked by citation count, the most notable is the article by Paechter M, published in Computers & Education in 2010, which has received 400 global citations. This is followed by Liu's 2009 article with 364 citations, and Lee's 2010 publication, which has been cited 170 times. Other influential works include those by Almahassees Z (2021), Pham L (2019), and Dai HM (2020), with citation counts of 168, 168, and 158, respectively.

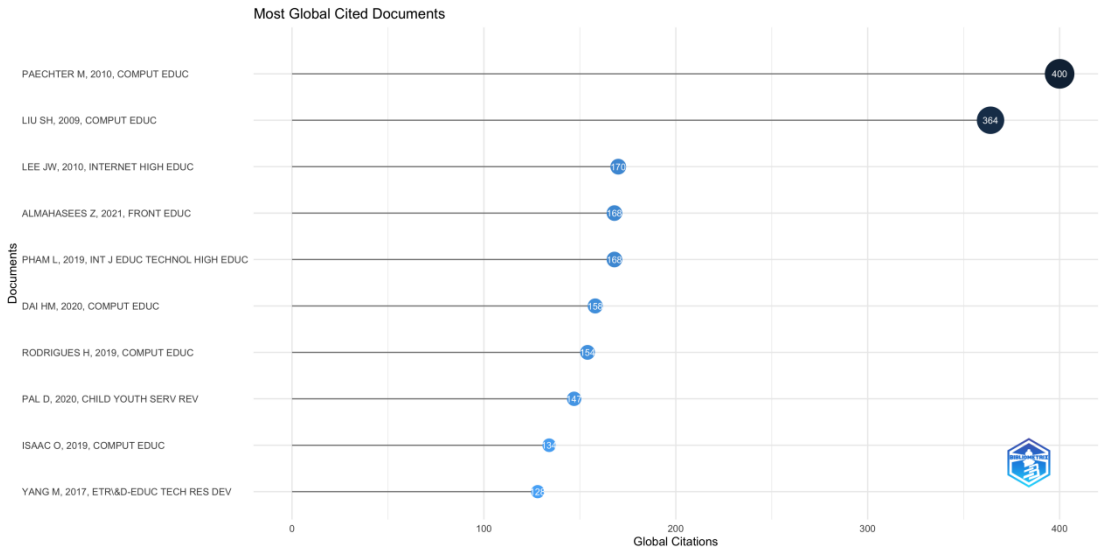

Figure 4 Top 20 most global cited documents published on Using Technology Acceptance Model to Study Higher Education Online Learning research field.

4.2 Analysis of Topics

Figure 5 presents a thematic map of research on satisfaction in the field of online learning in higher education using the Technology Acceptance Model. Each bubble represents a keyword network cluster, with the cluster names reflecting the most frequently occurring terms. Therefore, terms such as "acceptance," "satisfaction," "technology," "adoption," "engagement," and "teachers" are the most relevant thematic indicators. These themes are distributed across different areas of the map, showing their centrality and density, which indicates their importance and level of development within this research domain.

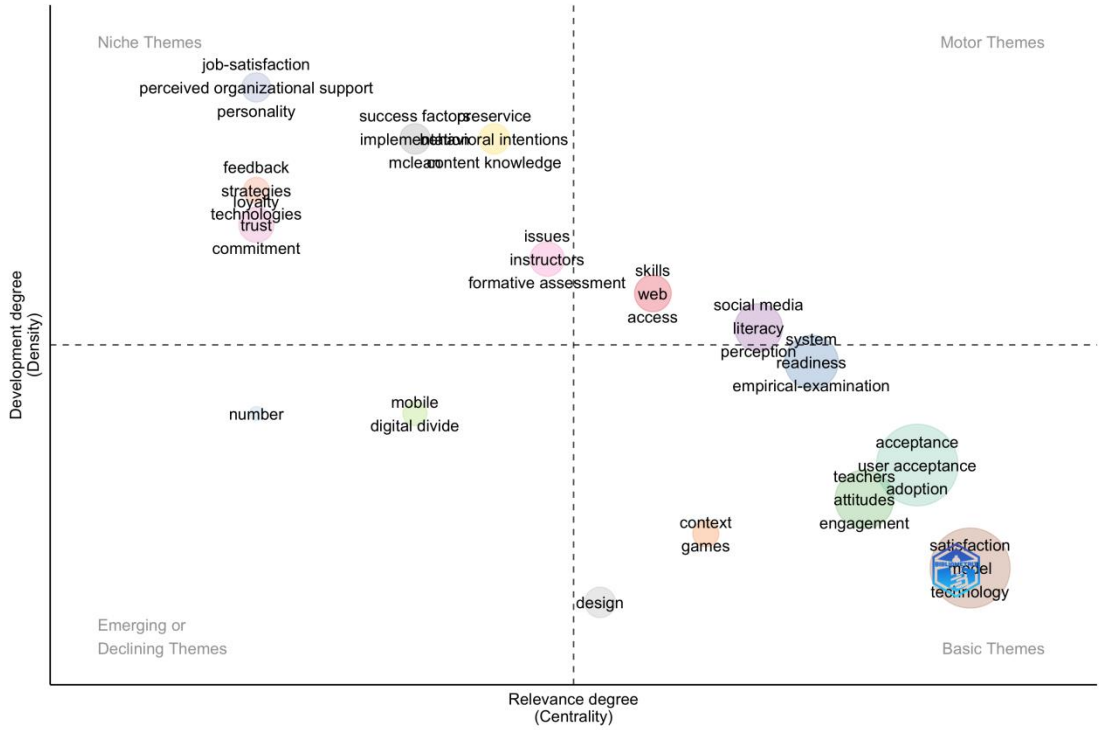

Figure 5 Thematic map of keywords network clusters in Using Technology Acceptance Model to Study Higher Education Online Learning

4.3 Analysis of Keywords

Figure 6 presents a three-field plot illustrating the close relationships among key authors, research keywords, and journals in the field of satisfaction studies on online learning in higher education. The central field represents the research keywords, the left field shows the authors, and the right field displays the journals where their articles were published. By analyzing this figure, we can gain insights into which keywords are the focus of academic attention and identify the main journal platforms that researchers prefer for publishing their work. This visualization helps to map the connections between influential authors, prevalent research themes, and prominent publication outlets in this domain.

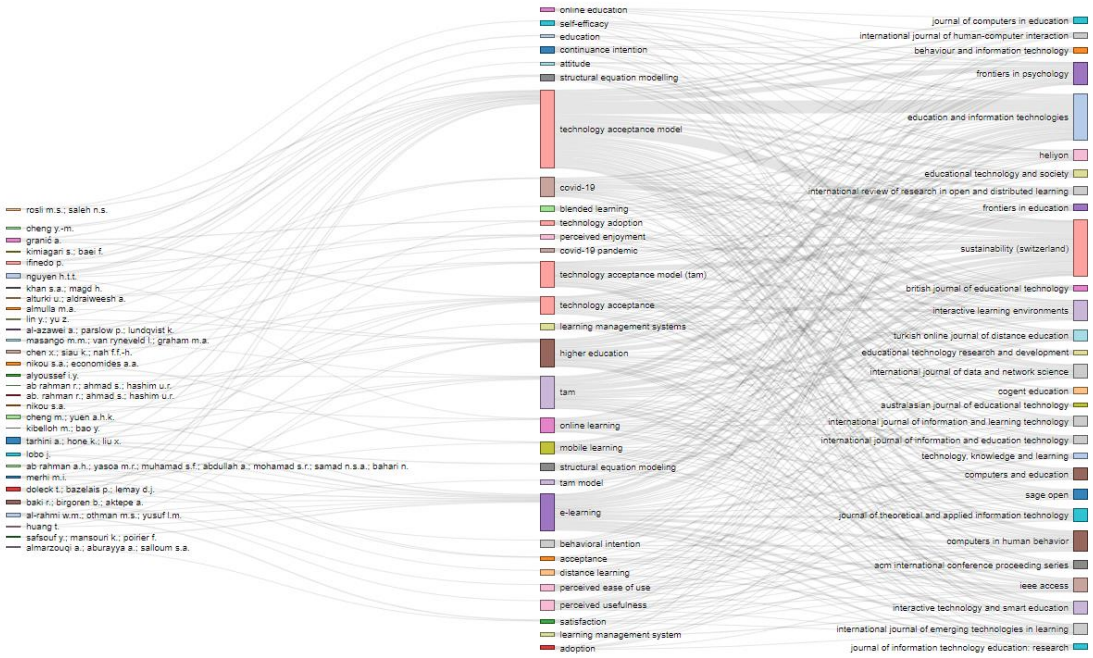

Figure 6 Three field diagram of the relationship between the top ranked keywords plus sign (middle field), top ranked authors (left field), and top ranked journals (right field) in the field of online learning in higher education using a technology acceptance model.

The figure reveals that key authors such as Rosli M.S., Cheng Y.M., and Granić A. are closely linked to keywords like "technology acceptance model," "online learning," and "self-efficacy." This indicates that these researchers have significant influence in the study of the Technology Acceptance Model and online learning satisfaction. Additionally, keywords like "technology adoption" and "blended learning" highlight current research trends, suggesting that scholars are actively exploring how technology impacts satisfaction in online learning within higher education. This focus reflects the ongoing interest in understanding the integration of technology in educational contexts.

In terms of journals, Journal of Computers in Education, Heliyon, and British Journal of Educational Technology have emerged as the primary platforms for researchers to publish their work. These journals focus on the intersection of educational technology, particularly on how technology is applied in learning and teaching contexts. For scholars studying online learning satisfaction in higher education, these journals hold significant academic influence. By analyzing this figure, researchers can better understand whether their research aligns with current trends and hot topics, thereby contributing to the further development of studies on satisfaction in online education.

Figure 7 illustrates the relationships between different keywords in the study of online learning in higher education using the Technology Acceptance Model (TAM), with correspondence analysis (CA)

applied as a data reduction technique to generate the visualization. The two dimensions in the figure represent the average position of each keyword, with the central point indicating the overall center of the research field.

• Blue cluster (left side): This cluster contains keywords related to "self-efficacy," "satisfaction," and "continuance intention." These keywords are spread more broadly, suggesting that these themes are relatively independent within the context of online learning in higher education. They represent the combination of technology and self-efficacy, highlighting their impact on students' learning processes.

• Red cluster (right side): This group includes keywords such as "technology acceptance model," "user acceptance," "adoption," and "information technology." The close proximity of these keywords indicates a strong interrelation within TAM research, particularly in the application and acceptance of technology in higher education.

The different color clusters in the figure help to reveal the distinct subfields within the study of satisfaction in online learning in higher education and the interconnectedness of the keywords. This provides valuable insights for further research and exploration, showing how various themes align and influence each other within the broader domain.

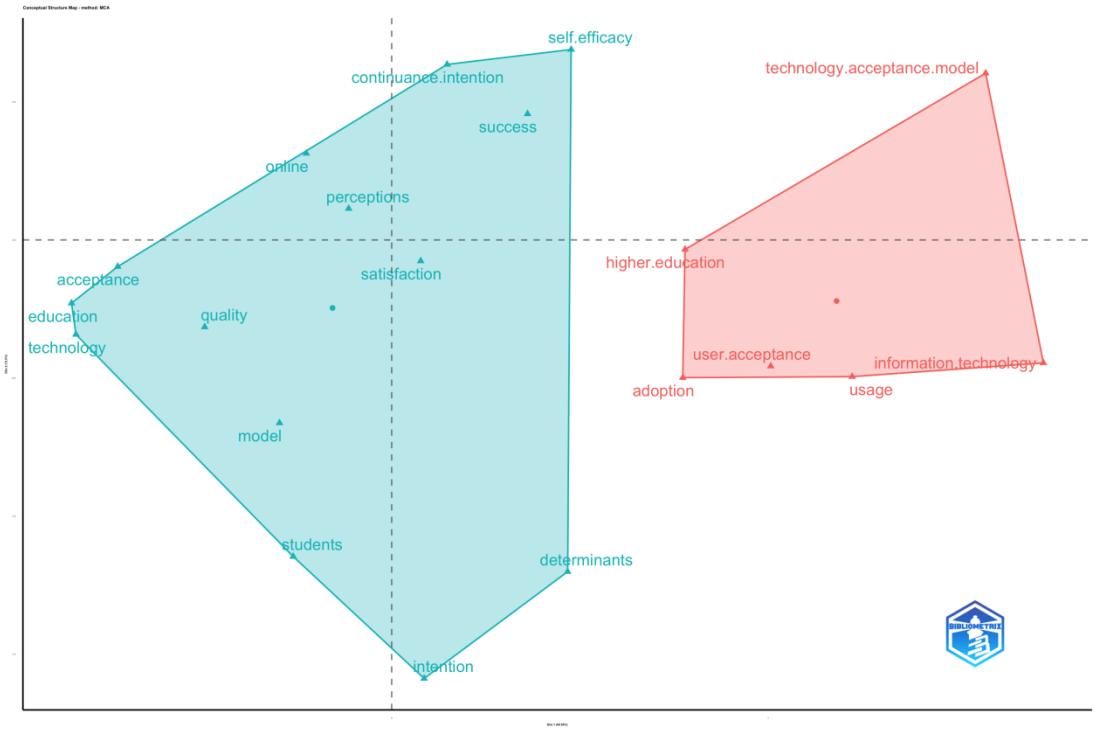

Figure 7 Conceptual structure map of keywords in Using Technology Acceptance Model to Study Higher Education Online Learning publications (Dim.1 and Dim.2: the average position of the articles included in each keyword).

Figure 8 illustrates the frequency of key terms used in research on satisfaction with online learning in higher education involving the Technology Acceptance Model from 2006 to 2024. Since 2015, keywords such as "technology," "satisfaction," and "acceptance" have seen a steady increase in frequency, with a sharp rise in occurrences after 2021. This trend reflects the rapid development of research in this field.

Simultaneously, keywords like "user acceptance," "adoption," and "online" have become more common in recent studies, indicating their growing relevance in the research landscape. In contrast, some terms had relatively low usage prior to 2021 but have gained prominence as research has deepened and the application of technology has expanded. This shift highlights the evolving focus of research on how technology impacts satisfaction with online learning in higher education.

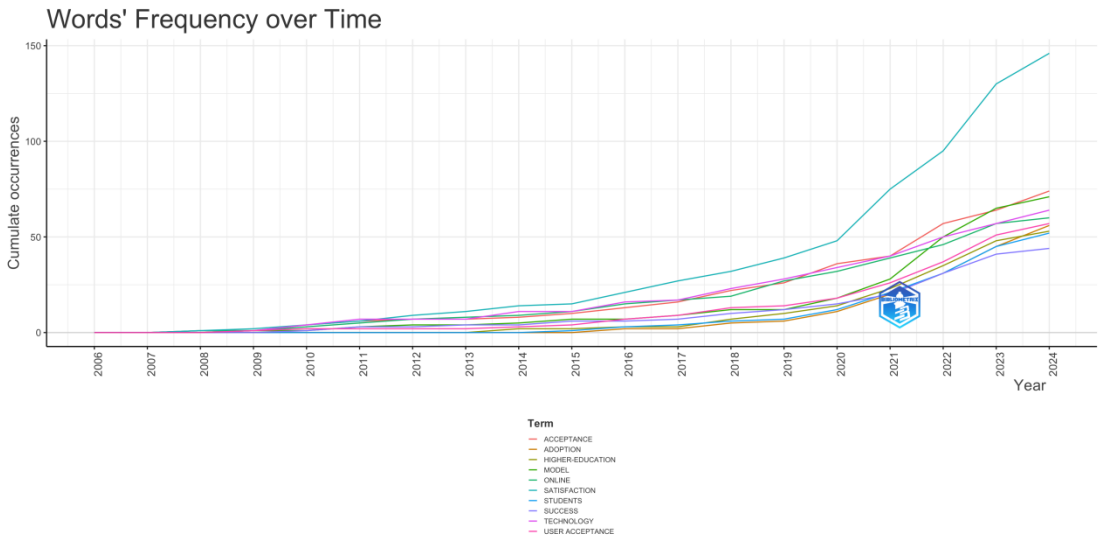

Figure 8 Annual occurrences of top keywords in Using Technology Acceptance Model to Study Higher Education Online Learning within 2006 to 2024 period

In conclusion, the Technology Acceptance Model has been widely used to predict and explain users' acceptance of e-learning. Numerous studies have integrated TAM with other theories, such as the Theory of Planned Behavior, to provide a more comprehensive understanding of the factors influencing e-learning acceptance. Additionally, external variables, including cultural, social, and economic contexts, have been considered to reveal their relationship with the acceptance of e-learning. These integrations contribute to a more nuanced understanding of the complex dynamics affecting the adoption of e-learning technologies.

In the future, research directions of Using Technology Acceptance Model to Study Higher Education Online Learning could include further exploration of deeper factors influencing e-learning acceptance,

such as psychological and emotional aspects. Additionally, investigating the differences in e-learning acceptance across various cultural and social contexts would provide valuable insights. Moreover, exploring new technologies and methods to enhance the effectiveness of e-learning and improve user experience is crucial. As technology advances and society evolves, research in this field will continue to deepen and expand.

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