Exploring research trends on AI-enabled wearable technologies for learning and teaching

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Abstract: *This study aims to determine the trend towards the use of AI-powered wearable technologies in the learning and teaching process. The study, which involved a bibliometric analysis of documents published in the Scopus database, focused on determining the distribution of documents by year, the year with the most citations, the most productive countries, and the most frequently used keywords in the published documents. The results show that documents related to this field were first published in 2004, but the most productive year was 2015. The year with the most citations was identified as 2013, while the most productive country was the USA, and the country with the most citations was the UK. The most frequently used keywords in the published documents were determined to be "wearable technology" and "artificial intelligence". Researchers conducting research in this field are advised to consider the results of this study as a guiding resource*.

Keywords: Artificial Intelligence, Education, Learning analytics, Student performance, Training, Teaching, Wearable technology.

1. Introduction

Wearable technologies are defined as the interaction between humans and computers; stimuli from the human body are considered by the technological device worn, providing feedback to the individual. In its simplest form, wearable technology can be explained as an individual wearing a technological device in any way. Today, technology has created a new phenomenon in which humans interact; wearable devices are defined as "smart electronic devices that are located near or on the human body in various forms" (Almusawi et al., 2021). Hayes (2025) describes these devices as 'electronic devices that are worn on the body like an accessory, embedded in clothing, or even tattooed on the skin'. Advanced wearable devices have microprocessors and internet connections that enable data transmission and usability (Hayes, 2025); examples include glasses, watches,

https://doi.org/10.58503/icvl-v21y202606

fitness trackers, and virtual reality headsets. These devices are technological tools worn close to the skin by humans, just like smartwatches, to transmit individual body data such as medical and exercise data to a device. Wearable devices, such as modern smartwatches, make it possible to continuously monitor people's movements and behaviors (Mekruksavanich et al., 2020).

The rapid spread and use of wearable technologies are primarily driven by the development of the internet. Wearable technologies have found applications in many areas of life in recent years; one of the most common areas of use is the healthcare sector (Van Til et al., 2019; Havard & Podsiad, 2020; Dursun & Yılmaz, 2021; Akıncı et al., 2022; Albayram & Öztekin, 2023; Serçe & Ovayolu, 2024). One of the aims of widespread use of wearable devices in the healthcare sector is to provide easier access to healthcare solutions for the health problems of the elderly through remote access (Fank & Chang, 2016; Dursun & Yılmaz, 2021; Turgut et al., 2023). Wearable devices generally consist of a power source, screen, wireless connectivity, motion detection, and an application processor (Kumari et al., 2017), enabling users to easily access online information. Wearable technologies, which enable individuals to communicate instantly with others while on the move, also facilitate mobility and connectivity (Burmaoğlu et al., 2018). Developments in the field of technology have particularly affected developments in wearable technology; it has been determined that this development has accelerated in the last few decades (Havard & Podsiad, 2020) and its use has increased significantly (Lee et al., 2015). In addition to medical and fitness uses, wearable technologies, which have begun to be used in other institutions, have also become frequently used in the field of educational sciences (Zeng & Motti, 2017; Atallah & Ilagure, 2018; Bozkurt, 2018; Kumar et al., 2018; Almusawi et al., 2021; Chu et al., 2023). Almusawi et al. (2021) states that these technologies are supportive technologies in the teaching process for learning. Many wearable devices hold an important place because they are ready to use, easily accessible, and can be easily integrated into education and training programs without requiring major changes (Chen et al., 2013; Zeng & Motti, 2017). The literature reveals that wearable devices mostly yield positive results and provide practical innovations in different educational contexts (Almusavi, 2021). Bozkurt (2018) showed that wearable technologies are directly related to accessible learning. Cheng & Tsai (2019), in their study, concluded that wearable technologies generally increase student motivation and especially reduce students' test anxiety. In addition, the study emphasized that spatial presence and perceptions of experienced reality play an important role in students' motivational beliefs. In the study by Engen et al. (2018), it was concluded that the use of wearable devices in teaching and learning provides pedagogical opportunities in different subjects and courses; however, it was also concluded that teachers and researchers need a lot of time to use these devices for teaching. In their study, Kumar et al. (2018) found that most features of smart glasses are compatible with the requirements of the teaching and learning process adopted in education. The results obtained from these studies have shown that wearable technologies have a positive impact on the field of education. In this context, it can

be stated that wearable technologies have the potential to be used in teaching processes (Lee et al., 2015) and have both instructional and non-instructional potential benefits (Havard & Podsiad, 2020). Bibliometric studies in the literature on AI-powered wearable technologies have identified the following as the main research directions: publication increase over the years, identification of interdisciplinary relationships, correlation of the most frequently used keywords, and future trends. However, researchers are cautious about the use of wearable devices in education, and Havard & Podsiad (2020) even emphasize that many studies lack rigorous research design and that the results are not conclusive. Almusawi et al. (2021), Havard and Podsiad (2020) also state that there is limited information regarding the expectations of innovation in education using wearable technology. In this context, the aim of this study is to identify research trends in AI-assisted wearable technologies in the learning and teaching process and to create a guiding resource for researchers who will conduct scientific studies in this field. To achieve the research objective, the following questions were addressed:

1. What is the distribution by year of published documents on the use of AI-powered wearable technologies in the learning and teaching process?
2. Which year received the most citations?
3. Which countries are the most productive?
4. Which countries receive the most citations for the published documents?
5. What are the most frequently used keywords in the published documents?

2. Method

This study, conducted to determine the trend regarding the use of AI-powered wearable technologies in the learning and teaching process, utilized a bibliometric analysis method. The study analyzed the distribution of documents published in the Scopus database by year, the most productive countries in the field, citations, and the most frequently used keywords in the documents. The Scopus database has a very broad scope in terms of journals, and its metadata fields such as "keywords," "abstract," "institution and country information," "citation counts by year," and "references" are considered ideal for bibliometric analyses. Furthermore, this structure in Scopus provides seamless integration for the Bibliometrix (R) tool used in this study. Scopus was also chosen for this study because it offers researchers extensive search capabilities for bibliometric studies. Data collection was limited to the “title, abstract, and keywords” sections of the documents, using the keywords “wearable technology*”, “artificial intelligence*”, “education”, “training”, “teaching”, “student performance”, or “learning analytics”. Data collection was completed on October 31, 2025.

For data analysis, bibliometrix, an open-source tool for quantitative research that includes bibliometric analysis methods, was preferred (https://www.bibliometrix.org/home/index.php/layout/bibliometrix). Developed by Aria & Cuccurullo (2017), bibliometrix; Bibliometrics is described as "a tool developed in R language for statistical calculation and graphing according to the

bibliometric workflow" (https://www.bibliometrix.org/home/index.php/layout/bibliometrix). In this study, Biblioshiny (https://www.bibliometrix.org/home/index.php/layout/biblioshiny), which provides a web interface for bibliometrics analyses and is described as a brilliant application, was used. "Bibliometrics provides resources to researchers for various purposes such as providing structured analysis of large amounts of information, identifying trends and themes over time, identifying the most productive countries, identifying the most relevant authors, and determining the distribution of studies by year" (Aria & Cuccurullo, 2017). In this study, bibliometrics was used to reveal the general picture of studies on the use of AI-supported wearable technologies in the learning-teaching process. Table 1 provides general information on the documents published in the Scopus database up to October 31, 2025, and included in the study.

Table 1. Main information about data

Description	**Results**
MAIN INFORMATION ABOUT DATA	
Timespan	2004:2026
Sources (Journals, Books, etc)	440
Documents	1104
Annual Growth Rate %	7,59
Document Average Age	3,3
Average citations per doc	23,36
References	0
DOCUMENT CONTENTS	
Keywords Plus (ID)	7500
Author's Keywords (DE)	2977
AUTHORS	
Authors	3964
Authors of single-authored docs	0
AUTHORS COLLABORATION	
Single-authored docs	0
Co-Authors per Doc	9,04
International co-authorships %	25,54
DOCUMENT TYPES	
article	369
book	16
book chapter	89
conference paper	434
conference review	5
editorial	12
letter	5

note	10
retracted	1
review	162
short survey	1

As shown in Table 1, all studies on AI-powered wearable technologies in the Scopus database were included in the bibliometric analysis. In this context, none of the studies published in Scopus in this field were excluded; all were included in the analysis. Studies on the use of AI-powered wearable technologies in the learning and teaching process were first published in the Scopus database in 2004. Examining the publication years of these studies, it was determined that the sources included documents published up to the year 2026. Although the data collection date for this study was October 31, 2025, it was found that some documents were published with a date of 2026. This situation can be attributed to the fact that the relevant publications were made available online at the end of 2025, but their official volume/issue or publication year was assigned as 2026. A total of 1104 documents covering the years 2004-2026 were published in 440 sources, including journals and books. In this field, where 3964 authors published documents, the most frequent type of study was conference papers with 434 publications. The next most preferred document type by researchers was articles with 369 documents. The other most preferred document types were, in order: The most preferred document types were review (n=162), book chapter (n=89), book (n=16), editorial (n=12), note (n=10), conference review and letter (n=5), while the least preferred document type was retracted and short survey (n=1).

3. Results

3.1 Distribution according to the most productive years

Figure 1 shows the distribution by year of studies conducted on the use of AI-powered wearable technologies in the learning and teaching process.

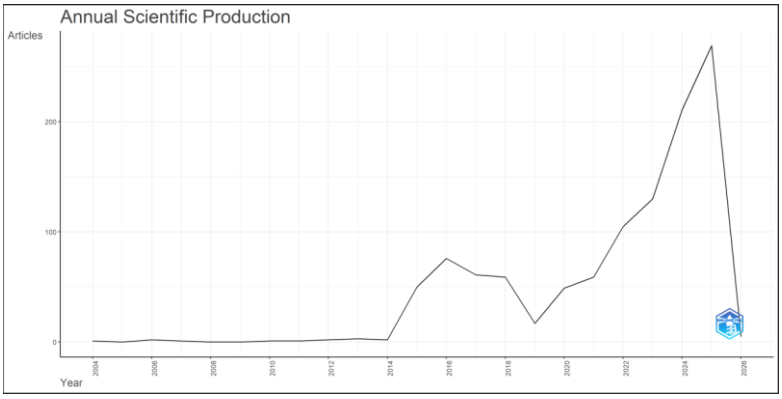

Figure 1. Annual scientific production

The most productive year for the publication of documents related to AI-powered wearable technologies was identified as 2025 with 269 publications. While the first document in this field was published in 2004, it can be said that the research gained momentum quantitatively, especially from 2022 onwards. The fact that 5 publications from 2026 are already mentioned in the sources, even though 2026 has not yet arrived, is an indication that productivity will continue. The distribution of the years with the most citations is given in Figure 2.

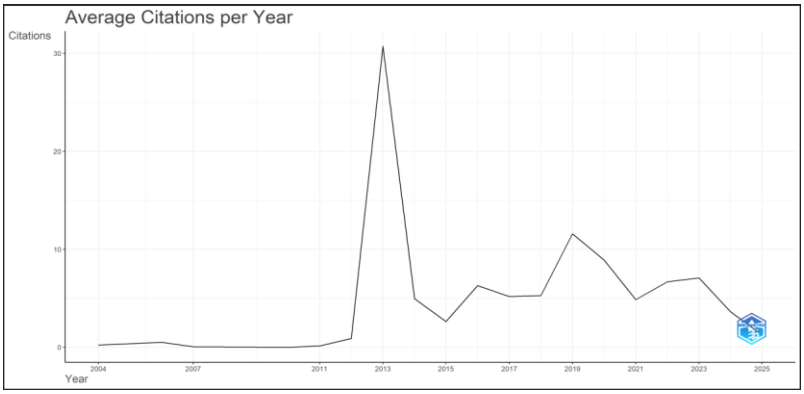

Figure 2. Average citation per year

The analysis revealed that 2013 was the year with the most citations for AI-powered interactive technologies. This finding indicates a high level of interest in documents published in 2013.

3.2 Distribution by most productive countries

This study also aimed to determine the productivity levels of countries conducting research on the use of AI-powered wearable technologies in the learning and teaching process. The distribution of the most productive countries is given in Table 2.

Table 2. Country production

Country	Freq
USA	1011
INDIA	763
CHINA	733
ITALY	317
UK	276
SOUTH KOREA	132
AUSTRALIA	112
SPAIN	112
GERMANY	98
CANADA	97

As shown in Table 2, the most productive country was the USA with 1011 documents. Other productive countries that produced the most publications on the use of AI-powered wearable technologies in teaching and learning activities were, respectively: India (f=763), China (f=733), Italy (f=317), UK (f=276), South Korea (f=132), Australia (f=112), Germany (f=98), and Canada (f=97). It is recommended that countries conducting research on the use of AI-powered wearable technologies in teaching activities should take as examples the countries that are pioneers in this field.

The countries with the most publications and citations in the field are given in Figure 3.

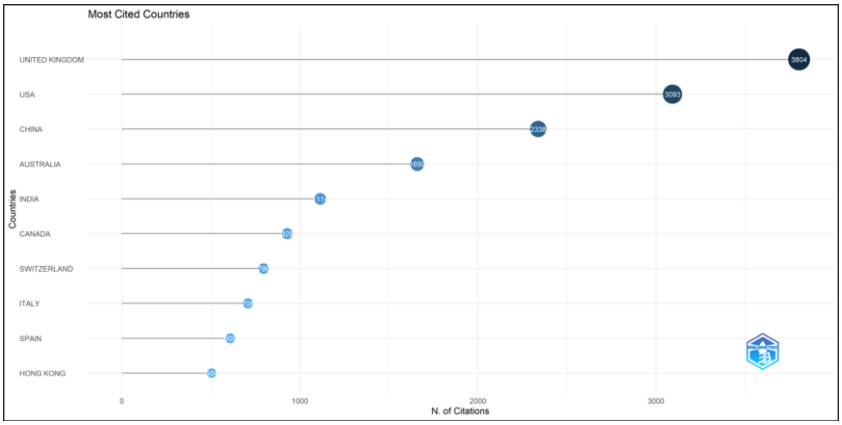

Figure 3. Most Cited Countries

The study identified the uk (n=3084) as the country with the most citations in documents related to AI-powered wearable technologies. The other countries with the most citations and ranking in the top 10 were, in order: USA (n=3093), China (n=2338), Australia (n=1659), India (n=1114), Canada (n=929), Switzerland (n=796), Italy (n=708), Spain (n=609), and Hong Kong (n=504).

3.3. Distribution of the most frequently used words in published documents

The most frequently used keywords in studies on AI-powered wearable technologies are given in Table 3.

Table 3. Most frequent word

Words	Occurrences
wearable technology	788
artificial intelligence	771
learning systems	394
machine learning	332
human	299
deep learning	233

humans	220
wearable devices	188
machine-learning	185
wearable sensors	170

As shown in Table 3, the most frequently used word in the documents by the researchers was identified as “wearable technology” (Occurrences=788). Other frequently used keywords in the published documents were, in order: “artificial intelligence” (Occurrences=771), “learning systems” (Occurrences=394), “machine learning” (Occurrences=332), “human” (Occurrences=299), “deep learning” (Occurrences=233), “humans” (Occurrences=220), “wearable devices” (Occurrences=188), “machine-learning” (Occurrences=185), and “wearable sensors” (Occurrences=170). Researchers who will conduct studies in this field are advised to consider the keywords listed in Table 3, especially during the literature review process.

4. Discussions and conclusions

This study aims to identify trends in the use of AI-powered wearable technologies in the learning and teaching process. Specifically intended to guide researchers in this field, the study focuses on the distribution of published documents by year, the most productive years, the most productive countries, the countries with the most citations, and the most frequently used keywords in the documents.

The study results show that the first document on the use of AI-powered wearable technologies in the learning and teaching process was published in 2004, but the most productive year was 2025. While interest in studies on the use of AI-powered wearable technologies began to increase quantitatively from 2022 onwards, the peak productivity was observed in 2025. The results indicate that the year with the most citations was 2013. In this context, it can be said that researchers cited more documents published in 2013. The countries with the most published documents and the highest productivity in this field are the USA, China, Italy, the UK, South Korea, Australia, Germany, and Canada. The UK was identified as the country with the most citations for its published documents. The top 10 countries with the most citations for their documents are, in order: USA, China, Australia, India, Canada, Switzerland, Italy, Spain, and Hong Kong. An examination of the most frequently used keywords by researchers in the published documents revealed that "wearable technology" and "artificial intelligence" were the most common. This study is limited to the trends presented by bibliometric data and does not directly measure classroom practices; it is merely a guide to indicate the direction of educational research. Researchers who will be conducting studies on the use of AI-powered wearable technologies in learning and teaching processes are advised to consider the results of this research, particularly during their literature review. The bibliometric analysis conducted in this study is limited to documents

published in the Scopus database and specific keywords. This has resulted in some themes being discussed in detail while others remain insufficiently visible. Therefore, it is recommended that future research focus on these neglected areas.

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