

# The Role of Artificial Intelligence Based Robots in Education: Transforming Learning and Teaching

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## Abstract

Rapid developments in the field of artificial intelligence have enabled robots, which have great potential to be used as educational technology, to become an important component in learning processes. In order to provide a better understanding of this development and to reveal trends, we present a review of the use of robots in education. In this context, 1061 articles were analyzed in Wos and Scopus databases with keywords such as social, humanoid robot. The data were merged with the R Studio program and analyzed through the bibliometrix package. The findings show that the use of robots in education has increased significantly in recent years, concepts such as artificial intelligence, machine learning and human-robot interaction have come to the forefront, and the use of artificial intelligence-supported robots in education has increased. This situation has both enriched the learning experiences of students and led researchers to conduct more studies in this field.

**Key words:** Artificial intelligence, social robots, humanoid robots, pedagogical robots, human-robot interaction.

## 1. Introduction

In recent years, rapid developments in technology and artificial intelligence have started to profoundly affect learning environments. Technology integration into learning environments has started to be reshaped with artificial intelligence and robots. Robots, which are considered as an innovative learning tool [1], are seen by many researchers as an innovation that can change current educational approaches and facilitate students' learning in different learning environments [2,3].

Traditionally, lego-style robots are only used to help students assemble and set up commands for programs; however, AI-embedded robots (AI-robots) can interact directly with humans using voice and image recognition techniques or natural language [1]. AI-enabled robots used in learning processes can provide personalized guidance and feedback [4], interact with students [5], and facilitate students to acquire necessary knowledge and skills without the need for a teacher [6]. Robots are used in many fields such as engineering, mathematics, programming [7], language teaching [8], online learning [9], health education [10] in learning processes. This situation encourages educators to use artificial intelligence-supported robots to achieve effective and efficient learning outcomes and to support students' individualized learning. Therefore, it is important to understand what these robots are and how they can be used in order to make them more accessible, affordable, effective and efficient in educational processes [11].

In the literature, many researchers conduct various studies to identify trends in specific research

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areas, but there is a limited number of studies that comprehensively examine the impact of artificial intelligence-supported robots on learning processes [6]. For this reason, examining the studies related to the research topic, revealing the trends and seeing the big picture can help researchers to understand the field and bring innovation to valuable studies. In this study, in order to eliminate the existing gap in the literature, studies examining the use of artificial intelligence-supported robots in education were analyzed by examining both Web of Science and Scopus databases.

## 2. Materials and Method

Provide In the study, bibliometric analysis method was used to analyze the articles. Bibliometric analysis provides an overview of research conducted in a particular subject area and provides in-depth analysis [12]. Bibliometric analysis is a visual description of the links between various disciplines, specific publications, keywords and authors [13].

In this study, data were obtained by searching Web of Science (WOS) or Scopus databases with relevant keywords (Figure 1).

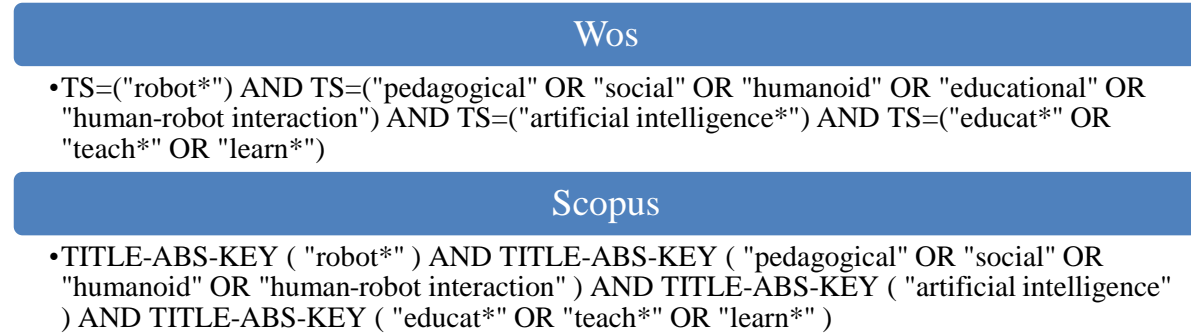


Figure 1. Database Search Query

Studies were included in the analysis based on the criteria that the language was “English”, the document type was “article” and the study was conducted before 2025 (Figure 2.).

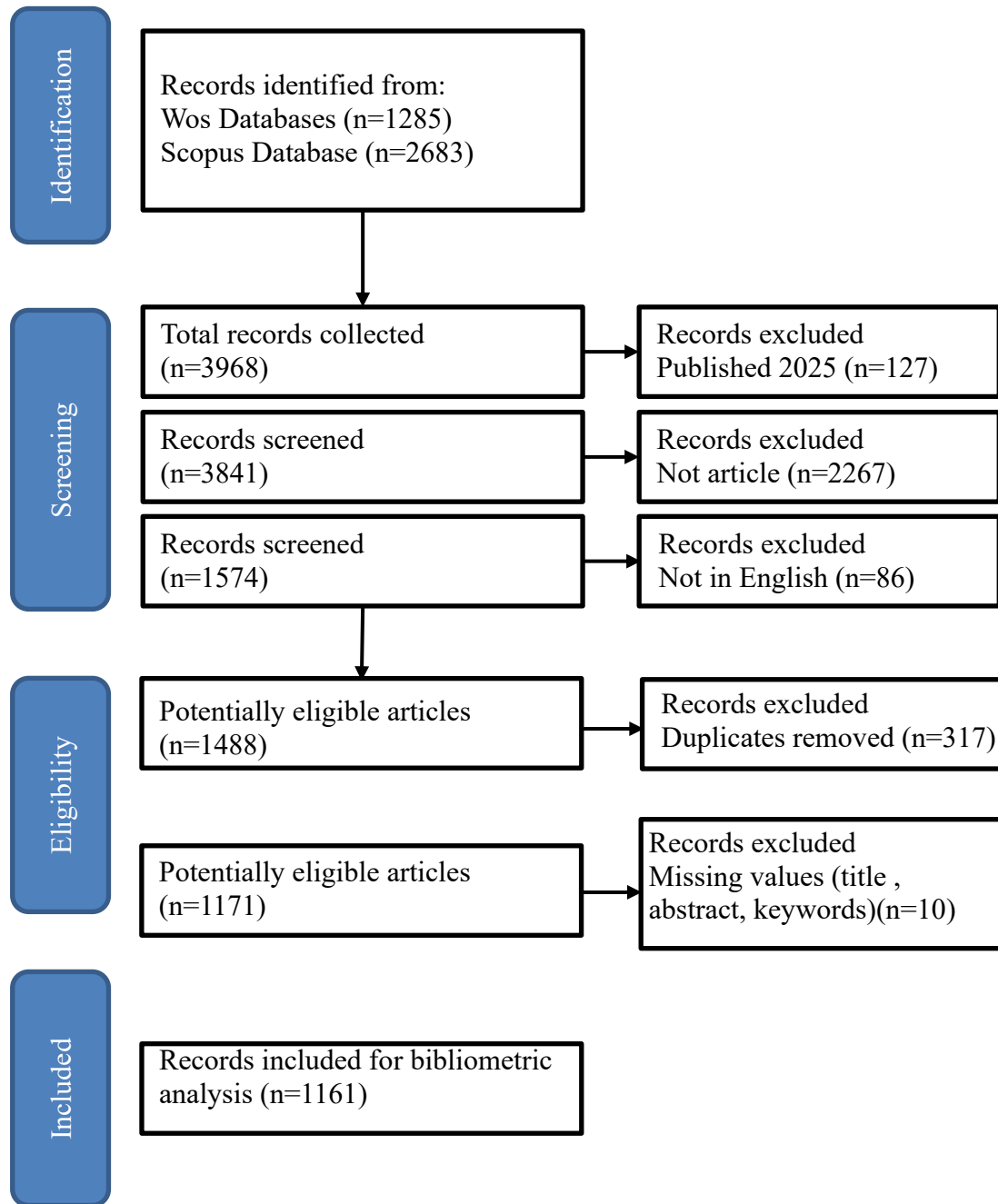


Figure 2. PRISMA declaration for the Process of Searching and Filtering Information Sources

In the study, the studies obtained from different databases were combined through the R program and analyzed with the bibliometrix package after duplications were removed.

### 3. Results

The descriptive statistics obtained from the study are presented in Table 1.

Table 1. Descriptive Statistics

Description	Results
Sources (Journals)	616
Documents (Article)	1161
Annual Growth Rate	4.47%
Average citations per document	28.48
Authors	3572
Authors of single-authored documents	174

When Table 1 is analyzed, it is seen that 1161 studies were published in 616 different sources and contributed by 3752 authors and 174 of the studies were single authored. It was concluded that the annual article growth rate was 4.47% and the average number of citations was 28.48.

### ***3.1. Distribution of Studies by Years***

When the distribution of the use of artificial intelligence-supported robots in education by years is examined, it was concluded that there was a great increase especially after 2018 and 2019, and it has been widely used since the 2020s.

### ***3.2. Most Active Authors Publishing Articles***

According to the data obtained from the studies, Li, Z, Zhang, Y and Wang, Y are the most published authors.

### ***3.3. Most Active Countries Publishing Articles***

According to the findings of the study, the USA (392), China (355) and the UK (157) are among the countries with the most frequent studies on the use of artificial intelligence-supported robots in education. Turkey ranks 27th with 16 studies. (if referred to explicitly in the text).

### ***3.4. Most used keywords and trend topic keywords***

Frequently used keywords in the study are shown in Table 2.

Table 2. Frequently Used Keywords

Artificial Intelligence	336
Machine Learning	128
Human-Robot Interaction	87
Robotics	79
Deep Learning	57
Education	50
Robots	45
Social Robots	29
Humanoid Robots	28
Reinforcement Learning	27

When Table 2. is examined, it is seen that concepts such as “Artificial Intelligence”, “Machine Learning”, “Human-Robot Interaction”, ‘Robotics’, “Deep Learning” are more commonly used.

### 3.5. Keyword Co-Occurrence Patterns

The network analysis method, expressed as frequency of co-occurrence, is shown in Figure 3 using the keywords in the study.

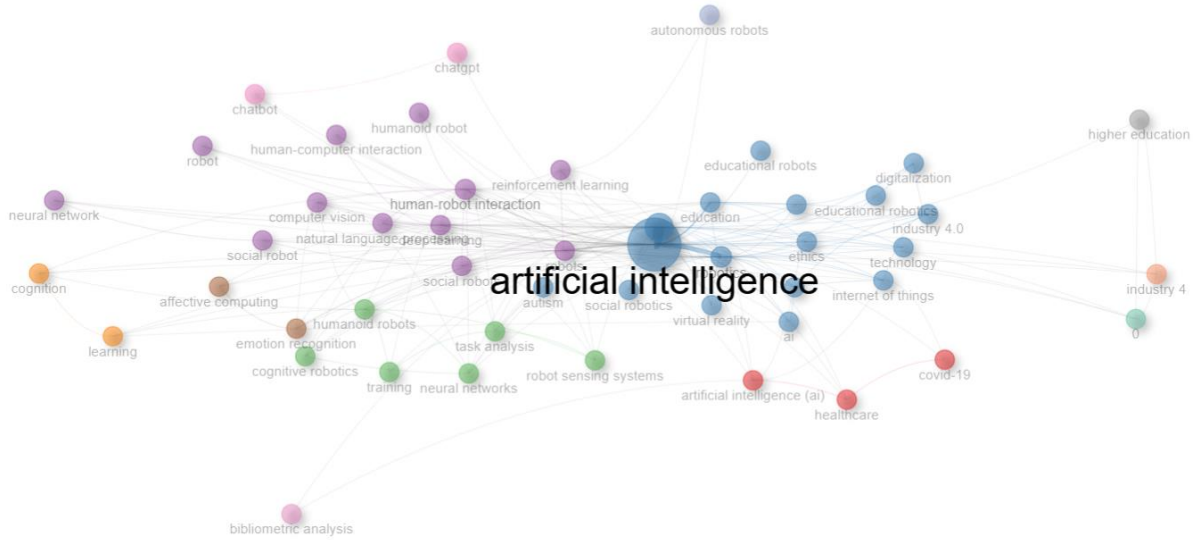


Figure 3. Co-occurrence of keyword analysis

Co-occurrence of keyword analysis shows that the terms “artificial intelligence” and “education” have a central position in the field of AI-supported robots in education and have strong relationships with many key concepts. In particular, the links with terms such as “human-robot interaction”, “educational robotics”, “social robotics” and “ethics” reveal that these technologies are addressed with a multidimensional and interdisciplinary approach in education.

### 3.6. Collaboration Network Analysis

Authors' collaboration network analysis is shown in Figure 4.

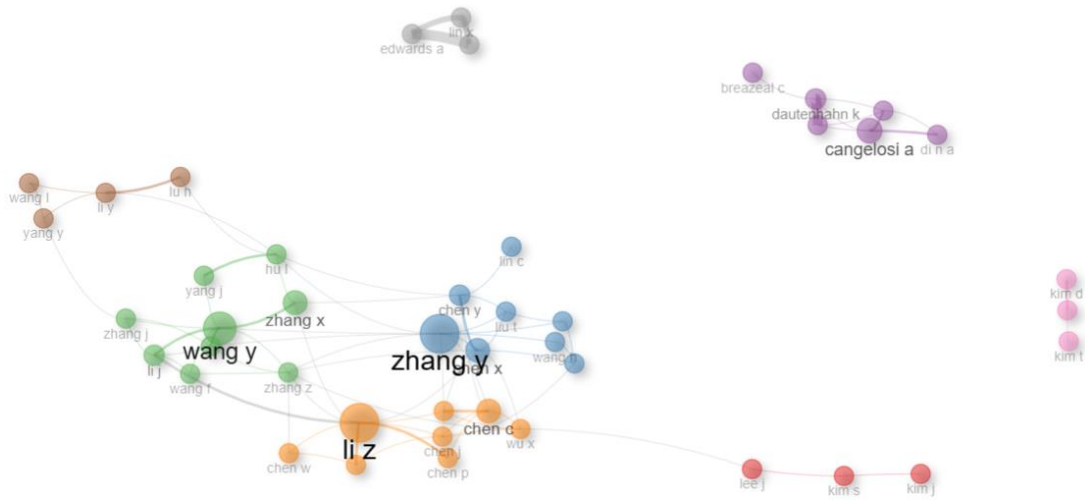


Figure 4. Author Collaboration network

Collaboration network analysis shows that there is an intense collaboration network in the field of artificial intelligence-supported robots in education, especially in the center of Zhang, Y, Li, Z and Wang, Y authors. It is seen that the studies are widely conducted in 7 different groups.

#### 4. Discussion

The analysis conducted within the scope of the study reveals that the use of artificial intelligence-supported robots in education has increased remarkably, especially after 2018. Especially the significant increase in the number of articles after 2020 shows that this field has attracted great interest in the scientific community. Different studies in the literature also show that the use of robots in education has become increasingly widespread in recent years [1, 14, 15]. The findings show that artificial intelligence-supported robots in education are still emerging and developing, and researchers and educators should pay more attention to moving their applications in education forward in order to strengthen and consolidate the education system [15].

It is seen that the studies mostly originate from the USA, China and the UK, and similarly, the authors who publish most frequently are from these countries. The fact that the USA has been a pioneer in the field of artificial intelligence and educational technologies for a long time, China has developed national strategies on artificial intelligence and conducted studies on robotic applications in education, and the UK has focused on social robots, ethical and pedagogical dimensions, and has opened the social acceptance of technology to discussion, not only technical but also social acceptance of technology, can be shown among the reasons for the current findings. Similar results have been reached in many studies in the literature [14, 15].

When the concepts in the studies are examined, the fact that the concepts of “artificial intelligence”, “education”, “human-robot interaction”, “social robotics”, “virtual reality” and “machine learning” are strongly at the center shows that there is an interdisciplinary interaction. This shows that artificial intelligence-supported robots are examined not only technically but also pedagogically and ethically. According to the timeline, while concepts such as “reinforcement learning”, “deep

learning”, “social robots” were present in the early period; in recent years, concepts such as ‘chatGPT’, “virtual reality” and “education” have started to be seen more frequently. This shows that with the evolution of technology, the purposes and contexts of use are also transforming. In the educational environment, the positioning of robots as interactive learning supporters, not just knowledge transmitters, supports learner-centered approaches. However, while Western researchers mostly focus on human-robot interaction, ethical and social dimensions, Asian studies focus on technological applications. Studies in the literature also support the findings [1, 15].

## Conclusions

In this study, the use of artificial intelligence-supported robots in education globally is examined from a broad perspective. The results show that the use of AI-assisted robots in education is on an upward trend in parallel with both technological developments and the transformation of pedagogical approaches. Bibliometric data reveals that this field has turned into a rapidly developing, interdisciplinary research field. The role of robots in education is not limited to being teacher assistants; they serve purposes such as interactive learning, individualized feedback and inclusive education. Future studies should delve deeper into the potential of these technologies to reduce educational inequalities and increase motivation to learn.

## Acknowledgements

The language translation of the study was done through the DeepL program.

## References

- [1] Chu, S. T., Hwang, G. J., & Tu, Y. F. (2022). Artificial intelligence-based robots in education: A systematic review of selected SSCI publications. *Computers and education: Artificial intelligence*, 3, 100091.
- [2] Evripidou, S., Georgiou, K., Doitsidis, L., Amanatiadis, A. A., Zinonos, Z., & Chatzichristofis, S. A. (2020). Educational robotics: Platforms, competitions and expected learning outcomes. *IEEE Access*, 8, 219534–219562. [https://doi.org/ 10.1109/ACCESS.2020.3042555](https://doi.org/10.1109/ACCESS.2020.3042555)
- [3] Lin, V., Yeh, H. C., & Chen, N. S. (2022). A systematic review on oral interactions in robot-assisted language learning. *Electronics*, 11(2), 290. <https://doi.org/10.3390/electronics11020290>
- [4] Chan, K. S., & Zary, N. (2019). Applications and challenges of implementing artificial intelligence in medical education: Integrative review. *JMIR medical education*, 5(1), Article e13930. <https://doi.org/10.2196/13930>
- [5] Papadopoulos, I., Lazzarino, R., Miah, S., Weaver, T., Thomas, B., & Koulouglioti, C. (2020). A systematic review of the literature regarding socially assistive robots in pre-tertiary education. *Computers & Education*, 155, Article 103924. <https://doi.org/10.1016/j.compedu.2020.103924>

- [6] Yang, J., & Zhang, B. (2019). Artificial intelligence in intelligent tutoring robots: A systematic review and design guidelines. *Applied Sciences*, 9(10), 2078. <https://doi.org/10.3390/app9102078>
- [7] Benitti, F. B. V., & Spolaôr, N. (2017). How have robots supported STEM teaching?. In *Robotics in STEM education* (pp. 103–129). Cham: Springer. [https://doi.org/10.1007/978-3-319-57786-9\\_5](https://doi.org/10.1007/978-3-319-57786-9_5).
- [8] Liu, C., Hou, J., Tu, Y. F., Wang, Y., & Hwang, G. J. (2021). Incorporating a reflective thinking promoting mechanism into artificial intelligence-supported English writing environments. *Interactive Learning Environments*, 1–19. <https://doi.org/10.1080/10494820.2021.2012812>
- [9] Hwang, G. J., Tu, Y. F., & Tang, K. Y. (2022). AI in online-learning research: Visualizing and interpreting the journal publications from 1997 to 2019. *International Review of Research in Open and Distance Learning*, 23(1), 104–130. <https://doi.org/10.19173/irrodl.v23i1.6319>
- [10] Chang, C. Y., Hwang, G. J., & Gau, M. L. (2022). Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training. *British Journal of Educational Technology*, 53(1), 171–188. <https://doi.org/10.1111/bjet.13158>
- [11] Woolf, B.P. Building Intelligent Interactive Tutors, Student-Centered Strategies for Revolutionizing E-Learning; Morgan Kaufman: Burlington, MA, USA, 2008.
- [12] Yıldız, M., & Yılmaz, T. K. (2023). Bibliometric Analysis in Scientific Research Using R: A Review of Scopus and Web of Science Databases. *Journal of Data Applications*, (2), 31-46.
- [13] Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of business research*, 133, 285-296.
- [14] López-Belmonte, J., Segura-Robles, A., Moreno-Guerrero, A. J., & Parra-Gonzalez, M. E. (2021). Robotics in education: a scientific mapping of the literature in Web of Science. *Electronics*, 10(3), 291.
- [15] Pai, R. Y., Shetty, A., Dinesh, T. K., Shetty, A. D., & Pillai, N. (2024). Effectiveness of social robots as a tutoring and learning companion: a bibliometric analysis. *Cogent Business & Management*, 11(1), 2299075.