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Systematic and Bibliometric Review on the Impact of Chatbots in Higher Education

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Abstract. In recent years, the use of chatbots in higher education has grown significantly, driven by advances in artificial intelligence and its ability to optimize teaching and learning processes. This paper presents a systematic literature review aimed at identifying the main trends, approaches, and findings related to the use of chatbots in higher education. An exhaustive search was conducted across five highly reputable academic databases (Scopus, EBSCOhost, ScienceDirect, Taylor & Francis Online, and ARDI), yielding an initial total of 42,188 documents. After applying strict inclusion and exclusion criteria, 69 scientific papers were selected for detailed analysis. The findings reveal that the most widely used programming language in the development of educational chatbots is R (45.2%), followed by Python and Java (22.5% each). In addition, 66.6% of the analyzed papers were published in Q1 journals, reflecting high-quality academic output in this field. These results confirm the growing interest in the application of chatbots in higher education and open new lines of research focused on pedagogical integration, assessment of academic impact, and the enhancement of personalized learning through conversational artificial intelligence.

Keywords. Chatbots, higher education, artificial intelligence, systematic literature review (SLR), education, intelligent bots, learning.

1 Introduction

In recent years, the integration of chatbots in higher education has emerged as a dynamic and rapidly expanding field of research, driven by advances in artificial intelligence (AI) and its potential to transform teaching and learning processes. These conversational systems, designed to simulate human interactions through text or voice, have demonstrated remarkable potential in delivering more personalized, accessible, and scalable educational experiences.

This growing interest unfolds within a global context in which higher education institutions seek to innovate pedagogical approaches and implement immediate feedback mechanisms that enhance academic quality. The review includes

various papers that examine the role of chatbots in higher education. First, the authors in [1] point out that digital transformation in Ghana is progressing slowly due to limited academic awareness of artificial intelligence and tools such as ChatGPT, recommending the promotion of technological awareness and early adoption. Complementarily, [2] shows that access to online resources and chatbots has transformed the teaching of writing and programming through interactive visualizations that generate personalized feedback and strengthen cognitive skills.

In [3], the perception of AI chatbots, particularly ChatGPT, among physics students at four universities is analyzed using a technology acceptance model, while [4] highlights their usefulness in academic advising by complementing human guidance and promoting educational equity for disadvantaged students. In the same line, [5] concludes that chatbot adoption mainly depends on perceived usefulness and ease of use, dismissing perceived risk as a relevant factor, and [6] argue that faculty acceptance in Saudi Arabia is conditioned by AI knowledge and motivation, recommending training and professional communities to facilitate their use. Convergently, [7] confirms that ease of use and perceived usefulness directly influence attitudes toward ChatGPT, while [8] reports positive student interactions with a pedagogical chatbot supporting language practice, though with limitations. In [10], the factors influencing chatbot adoption among university students for educational purposes are examined using the diffusion of innovations theory framework. In [11], it is determined that undergraduate students' adoption of chatbots primarily depends on perceived advantages, compatibility, and trial opportunity, whereas perceived usefulness does not directly affect usage intention. Likewise, [12] presents a chatbot designed to simulate interviews in a master's course, whose performance proves comparable to that of instructors and generates high levels of satisfaction, evidencing its potential in learning. Similarly, [15] reports that the use of a mobile chatbot in nursing training within higher education improves decision-making, achievement, and self-efficacy among students, outperforming traditional methods and fostering engagement. In contrast, papers [16, 17] address the ethical challenges of using ChatGPT and other AI chatbots in education, proposing frameworks for their responsible integration.

Furthermore, [18] states that artificial intelligence contributes to creating an inclusive environment for students with special needs in higher education institutions in Lebanon. Likewise, [19] highlights that a personalized chatbot based on generative AI improves project management instruction through individualized feedback and greater student participation. In turn, [20] reveals how generative AI is transforming education from the perspective of educators and leaders, raising practices, policies, and future research directions. In contrast, [21] warns that although AI chatbots may enhance academic performance, they can also negatively affect social well-being, such as increased loneliness and a diminished sense of belonging, impacting student success and retention. The authors in [22] raise concerns regarding the academic authenticity issues prompted by ChatGPT-3, proposing its use as a tool to create positive learning environments that build character and foster authentic assessments aimed at improving educational outcomes.

Additionally, [23] notes that conversational agents such as ChatGPT improve the perception of knowledge updating in virtual learning environments. In [30], the adoption of generative artificial intelligence in higher education presents key challenges such as training risks, result reliability, and lack of regulation. These factors influence policy formulation and the evolution of the sector. In [32], ChatGPT's self-learning and personalization capabilities are emphasized as enhancing knowledge acquisition and usage intention among university students, although barriers related to privacy, technophobia, and guilt persist, while innovation drives its adoption.

Complementarily, [33] presents a chatbot capable of personalizing educational recommendations in Moodle according to students' learning styles, adapting content in real time and improving their experience. Likewise, [43] shows that AI chatbots guided by mind maps in flipped classrooms significantly improve academic performance and oral interaction in English. In contrast, [50] examines the risks posed by AI chatbot use concerning academic integrity among higher education students. At a macro level, [76]

and [77] reveal that research on chatbots in education has grown steadily, led by the United States, the United Kingdom, and China, with relevant international collaborations but limited participation from Africa. Additionally, [79] indicates that chatbot use in universities is primarily aimed at improving educational service quality and institutional management, while [81] concludes that their impact on learning outcomes ranges from moderate to high. In a broader analysis, [83] identifies that artificial intelligence affects teaching, learning, and educational administration, albeit with differences across academic levels.

Similarly, [87] argues that chatbots, primarily implemented on web platforms, increase student satisfaction and can serve as teaching agents or virtual companions, and [89] confirms that they moderately improve performance in STEM fields, textual interactions, and long-term programs. Furthermore, [90] highlights their increasing application in language teaching, while [95] underscores ChatGPT's exponential growth in education, accompanied by key research and collaborations. Finally, [97] concludes that educational chatbots, diverse in type and technology, reinforce learning and fulfill functions similar to those of human tutors.

The incorporation of chatbots in higher education calls for rigorous analysis that transcends isolated studies and enables the synthesis of available evidence. Although the literature highlights benefits in personalization, feedback, and academic management, it also points to ethical and authenticity-related challenges that require comprehensive evaluation. In this context, a systematic literature review is essential to identify trends, gaps, and key contributions, offering a critical perspective to guide future research and institutional practices related to chatbot use in higher education. The general objective of this study is to determine the state of knowledge regarding research addressing the use of chatbots and their impact on higher education, through a systematic review that enables the consolidation of an integral vision of this field. This paper is structured as follows: Section 2 presents the background, Section 3 describes the methodology, including the review process, exclusion criteria, article quality assessment, and the PRISMA flow diagram summarizing the procedure applied. Section 4 presents the results and discussion, organized according to the research questions posed. Finally, Section 5 outlines the conclusions, highlighting the main findings and offering guidance for future studies.

2 Background

This section presents a structured analysis of the keywords associated with the study of chatbots in higher education, as well as the tools used for bibliometric analysis and information management in systematic reviews.

2.1 Chatbots

The use of chatbots has expanded significantly across various sectors due to their ability to automate interactions through artificial intelligence, with notable applications in education, healthcare, and e-commerce. In the educational domain, Kuriakose and colleagues [88] highlight sustained growth in recent publications, emphasizing their implementation in computer science, social sciences, and engineering, both for learning support and academic management. Lin and Yu [90] point out that, in addition to automating assistance, chatbots personalize teaching and enhance the student experience.

Likewise, McGrath, Farazouli, and Cerratto-Pargman [92] underscore the potential of generative chatbots in higher education to promote critical thinking, automated reasoning, and dynamic content adaptation. In the healthcare sector, Omarov and collaborators [94] demonstrate how chatbots provide support in mental health through emotional assistance and confidential assessments, while Albites-Tapia and other researchers [74] highlight their effectiveness during the COVID-19 pandemic in detection and guidance tasks during emergency situations. In the business domain, Gamboa-Cruzado and collaborators [84] state that chatbots optimize customer service by delivering immediate responses and reducing operational costs; while in e-commerce, their contribution is emphasized in supporting purchasing decisions through

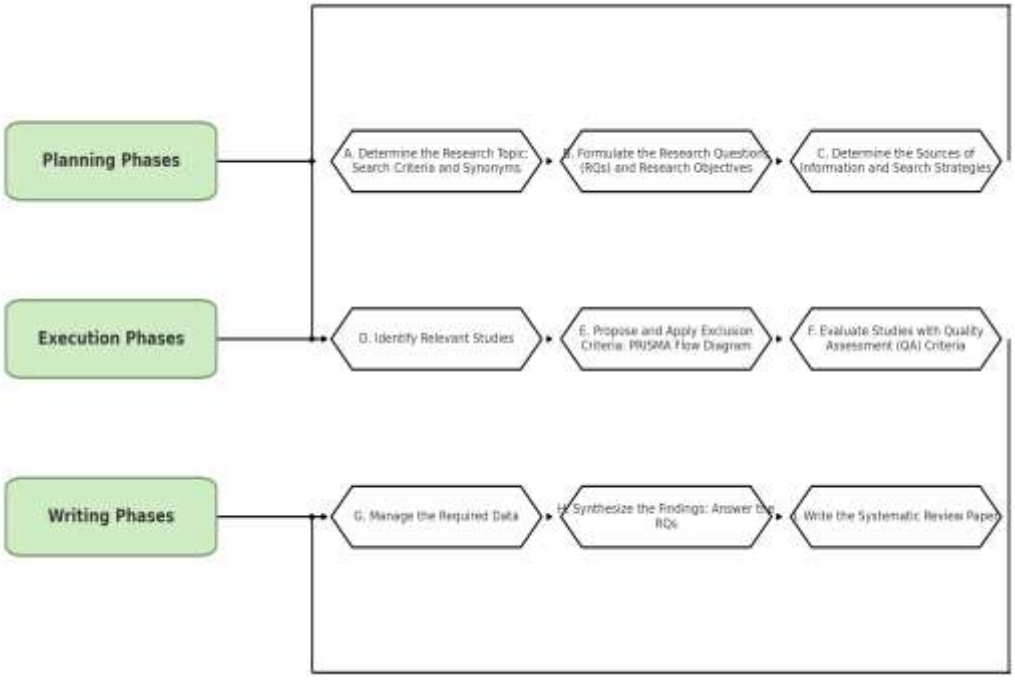

Fig. 1. Stages of the SLR conducted

personalized recommendations and real-time query resolution [85].

2.2 Higher Education

Higher education represents the primary context for the analysis and implementation of chatbots in the reviewed literature. Jiménez-García and colleagues [86] link these technologies to the Sustainable Development Goals, highlighting their potential to promote inclusive and sustainable education. Fu, Weng, and Wang [83] compare the application of educational artificial intelligence across different levels, emphasizing the centrality of higher education. Complementarily, Al-Zahrani and coauthors [76] and Rodríguez and Naval [90] underscore that countries with robust university infrastructures lead in chatbot adoption, with digital literacy and institutional readiness being decisive acceptance factors. In this regard, Kuriakose and his team [88] note their application in fields such as engineering and programming, while Fu, Weng, and Wang [83] stress their usefulness in administrative management. Likewise, Calvaresi and colleagues [78] and Lin and Yu [90] identify university students and faculty as the main users, confirming the relevance of this educational level.

Finally, Polat and collaborators [95] conclude that most research on ChatGPT is concentrated in university and medical contexts, positioning higher education as the core of educational AI. In summary, this level not only constitutes the priority setting for chatbot implementation but also the space where they generate the greatest impact on learning and management, although their adoption faces challenges related to data protection, academic dishonesty, and the integration of ethical principles in their use.

3 Methodology

3.1 Research Protocol

The central purpose of this paper is to provide a detailed account of the methodological steps required to conduct a Systematic Literature Review (SLR). Likewise, it addresses and discusses bibliographic mapping approaches that enable the

Table 1. Research questions and objectives

Research Question	Objective
RQ1: What programming languages are being used in the development of chatbots?	Classify the different programming languages currently used in chatbot development.
RQ2: What are the quartile levels of the journals where research on the impact of chatbots in higher education has been published?	Determine the quartile levels of the journals in which research on the impact of chatbots in higher education has been published.
RQ3: Who are the authors that frequently collaborate as co-authors in studies on chatbot use and its influence in higher education?	Group authors who exhibit frequent co-authorship relationships in order to analyze collaborative dynamics in the scientific production on chatbots in higher education.
RQ4: What thematic categories are present in studies on chatbot use and its influence in higher education?	Identify and group papers whose abstracts show similarity regarding the impact of chatbots in higher education.
RQ5: What keywords frequently co-occur in research on chatbots and their influence in higher education?	Investigate the keywords with the highest frequency of co-occurrence in research on chatbots in higher education.

visualization of information and bibliometric findings derived from an SLR, as outlined by Linnenluecke, Marrone, and Singh [71].

This work also aims to serve as a reference guide for students and researchers who require a comprehensive view of their field of study. From a methodological standpoint, Kitchenham and Charters [70] emphasize that the goal of an SLR is to evaluate and interpret all relevant research available in relation to a research question, for which it is essential to apply reliable procedures. Similarly, Petersen, Vakkalanka, and Kuzniarz [72] highlight the importance of Systematic Mapping Studies (SMS), whose objective is to structure a research area through the classification and organization of scientific contributions.

Figure 1 illustrates the structured process followed in a Systematic Literature Review (SLR).

3.2 Research Problems and Objectives

This Systematic Literature Review (SLR) focuses on analyzing the growing use of chatbots and their impact on higher education. For this reason, it is essential to formulate the following research questions (RQs) and establish the corresponding objectives.

Table 1 organizes these questions into two main categories, descriptive and analytical, each accompanied by a specific objective that guides the purpose of the analysis and defines this study's contribution.3.3 Sources of Information and Search Strategies.

This section describes the sources of information used in the development of the present systematic review.

3.3.1 Sources of Information

To gather relevant scientific literature, widely recognized academic databases with international coverage were consulted, including EBSCOhost, ScienceDirect, Scopus, Taylor & Francis Online, and ARDI. These databases were selected for their rigor, accessibility, and relevance in disseminating research related to the topic under study.

3.3.2 Search Terms and Their Synonyms

The search strategy was designed based on key terms aligned with the research objective, complemented by synonyms to broaden coverage and ensure thorough retrieval of studies (see Table 2).

3.3.3 Search Equations

The search equations were formulated using Boolean operators (AND, OR) and exact phrases enclosed in quotation marks, adapting them to the specific syntax and requirements of each academic database. This customization allowed for the optimization of both the precision and breadth of the results, thereby ensuring the retrieval of relevant literature. The search strings

Table 2. Descriptors and their synonyms used in the search equations

Descriptor	Description
chatbots, conversational agent, smart bots, ai agents	Independent Variable (IV)
advanced education, higher education, education, study, teaching	Dependent Variable (DV)

Table 3. Search equations

Source	Search Equation
Science Direct	Title, abstract, keywords: (chatbot OR "conversational agent" OR "smart bots" OR "ai agents") AND ("advanced education" OR "higher education" OR education OR study OR teaching)
EBSCO host	(chatbot OR "conversational agent" OR "smart bots" OR "ai agents") AND ("advanced education" OR "higher education" OR education OR study OR teaching)
Scopus	(TITLE-ABS-KEY (chatbot OR "conversational agent" OR "smart bots" OR "ai agents") AND TITLE-ABS-KEY ("advanced education" OR "higher education" OR education OR study OR teaching))
Taylor & Francis Online	[[All: chatbot] OR [All: "conversational agent"] OR [All: "smart bots"] OR [All: "ai agents"]] AND [[All: "advanced education"] OR [All: "higher education"] OR [All: education] OR [All: study] OR [All: teaching]]
ARDI	(chatbot OR "conversational agent" OR "smart bots" OR "ai agents") AND ("advanced education" OR "higher education" OR education OR study OR teaching)

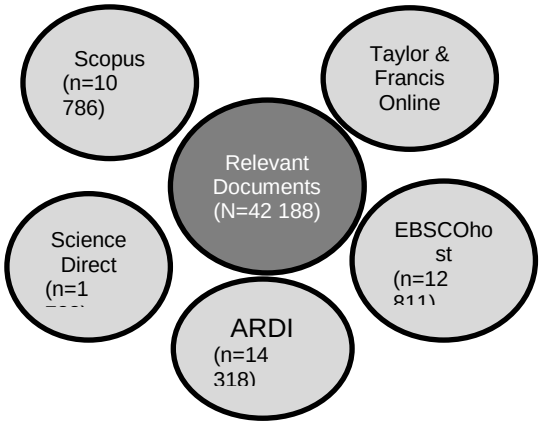

Fig. 2. Distribution of documents by source

constructed for each source are presented in Table 3.

3.4 Identified Studies

In the initial phase of the systematic literature review, a comprehensive search was conducted across various internationally recognized scientific databases to identify relevant studies on the use of chatbots and their impact on higher education. Figure 2 presents the distribution of the retrieved documents according to each consulted source, reflecting the contribution of these databases to the analytical corpus.

3.5 Study Selection

The study selection was carried out using nine exclusion criteria (EC) based on PRISMA and Kitchenham guidelines, aimed at reducing bias, ensuring up-to-date coverage, and maintaining thematic consistency. Books, book chapters, theses, systematic or bibliometric reviews, publications older than seven years, documents in languages other than English, those without full-

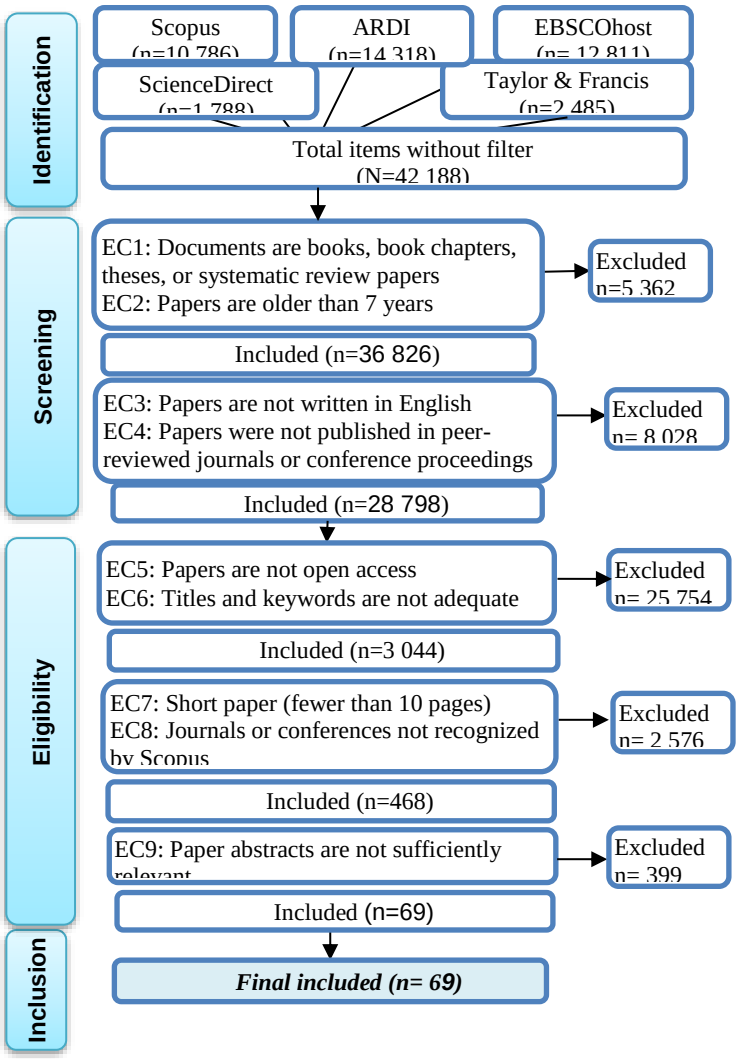

Fig. 3. PRISMA flow diagram

text access, non-indexed in Scopus, or whose titles, abstracts, or keywords did not adequately reflect the object of study were excluded.

The sequential application of these criteria refined the initial universe and ensured the inclusion of relevant and methodologically robust research. The entire process is summarized in the PRISMA diagram (Figure 3), which illustrates the phases of identification, screening, eligibility, and inclusion, thereby ensuring transparency in the review. After selecting the relevant papers, a quality assessment (QA) was conducted to ensure that the studies included in the systematic review met essential criteria of validity, clarity, and relevance. This process made it possible to recognize both the strengths and the methodological limitations of each study.

The assessment was carried out using a structured checklist of guiding questions, applying seven quality criteria (QA1 to QA7) that served as a framework for objectively evaluating the consistency and pertinence of the reviewed papers:

QA1: Are the research objectives clearly defined?

Table 4. Quality assessment of the studies

Ref	Tipo	QA1	QA2	QA3	QA4	QA5	QA6	QA7	Score
[1]	Journal	3	3	2	2	2	3	3	18
[2]	Journal	2	2	3	2	2	2	3	16
[3]	Journal	3	2	2	2	3	3	3	18
[4]	Journal	2	2	2	2	1	2	2	13
[5]	Journal	3	3	3	2	2	2	1	16
[6]	Journal	2	2	3	3	2	3	3	18
[7]	Journal	2	3	2	2	3	2	2	16
[8]	Journal	2	3	2	1	2	3	1	14
[9]	Journal	3	3	1	2	2	3	2	15
[10]	Journal	3	3	3	2	2	3	2	17
[11]	Journal	3	2	1	2	3	3	2	16
[12]	Journal	3	3	2	2	2	3	3	18
[13]	Journal	2	3	2	3	3	3	3	19
[14]	Journal	2	2	2	2	2	2	2	14
[15]	Journal	2	3	2	1	2	3	2	15
[16]	Journal	3	2	2	3	2	3	2	17
[17]	Journal	2	2	2	3	2	1	2	14
[18]	Journal	3	2	2	2	2	3	2	16
[19]	Journal	3	2	2	3	2	3	2	17
[20]	Journal	2	2	3	1	2	3	2	15
[21]	Journal	2	2	1	1	2	2	2	12
[22]	Journal	2	3	2	2	3	2	3	17
[23]	Journal	3	3	3	2	2	3	3	19
[24]	Journal	3	3	2	2	2	2	2	16
[25]	Journal	3	3	3	3	2	3	3	20
[26]	Journal	2	2	1	2	2	2	2	13
[27]	Journal	2	2	3	2	2	2	3	16
[28]	Journal	2	2	1	2	3	2	2	14
[29]	Journal	3	2	2	3	3	2	3	18
[30]	Journal	3	3	3	3	2	3	3	20
[31]	Journal	3	2	2	2	1	3	2	15
[32]	Journal	2	2	2	1	1	3	2	13
[33]	Journal	3	3	1	2	2	3	2	16
[34]	Journal	3	2	2	3	2	3	3	18
[35]	Journal	2	2	1	2	2	1	2	12
[36]	Conference	2	1	2	3	2	2	2	14
[37]	Journal	3	3	2	2	1	2	2	15
[38]	Journal	2	2	2	3	2	2	1	14
[39]	Journal	3	1	2	2	2	2	3	15
[40]	Conference	3	3	3	2	2	3	3	19
[41]	Journal	3	3	3	2	3	2	2	18
[42]	Journal	2	1	2	2	2	3	2	14
[43]	Journal	3	2	2	3	2	2	2	16
[44]	Journal	2	1	2	2	2	2	3	14
[45]	Journal	2	1	2	3	2	2	3	15
[46]	Journal	3	3	3	2	2	2	3	18
[47]	Journal	2	2	3	2	1	1	2	13
[48]	Journal	3	3	2	3	2	3	2	18
[49]	Journal	3	2	2	3	1	2	3	16
[50]	Journal	2	1	2	2	3	2	2	14
[51]	Journal	2	2	3	2	3	2	2	16
[52]	Journal	3	3	2	2	2	1	2	15
[53]	Journal	3	2	2	2	3	2	3	17
[54]	Journal	2	2	1	2	2	2	2	13
[55]	Journal	3	2	3	2	2	2	3	17
[56]	Journal	2	1	2	2	2	2	3	12
[57]	Journal	3	2	2	2	1	2	2	14
[58]	Journal	3	2	2	3	2	2	3	17
[59]	Journal	2	2	1	1	2	2	2	12
[60]	Journal	2	2	3	1	2	2	3	15
[61]	Journal	3	3	1	2	3	2	2	16
[62]	Journal	3	2	2	3	2	2	3	17
[63]	Journal	2	2	2	1	2	3	2	14
[64]	Journal	3	2	2	2	3	3	2	17
[65]	Journal	2	2	2	3	3	2	3	17
[66]	Journal	2	3	2	2	2	1	3	15
[67]	Journal	3	2	2	3	1	3	2	16
[68]	Journal	3	3	2	2	2	3	2	17
[69]	Journal	3	2	2	1	2	2	2	14

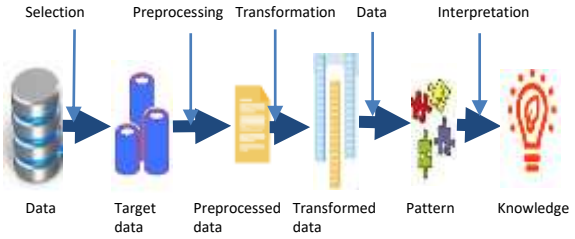

Fig. 4. Additional processing of the selected documents

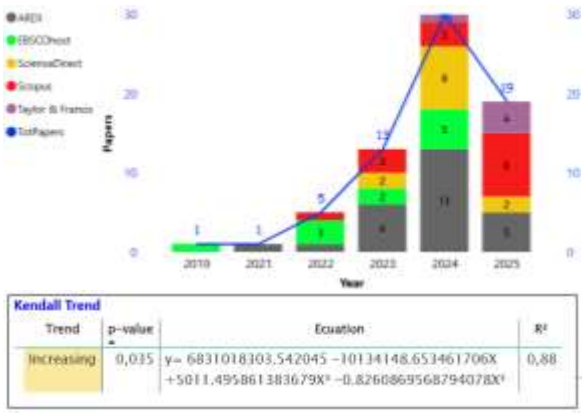

Fig. 5. Articles per year

QA2: Is the study design oriented toward achieving those objectives?

QA3: Have the indicators used in the study been measured appropriately?

QA4: Is there a clear and detailed description of the methods employed to collect the data?

QA5: Has the collected information been adequately described?

QA6: Is the purpose of the data analysis clearly explained?

QA7: Have the research questions been satisfactorily answered?

To assess the methodological quality of the studies included in the systematic review, a structured evaluation system called Quality Assessment (QA) was applied. This procedure allowed for the objective rating of each paper based on predefined criteria, thereby ensuring the robustness and reliability of the results.

A three-level scale was used:

1 (Poor): The study does not adequately meet the criterion, presenting methodological weaknesses, lack of clarity, or insufficient information.

2 (Good): The study reasonably satisfies the criterion, though with areas for improvement. The information is understandable and useful but not fully comprehensive.

3 (Very good): The study fully meets the evaluated criterion, showing clarity, methodological rigor, and well-structured solid evidence.

Based on these ratings, a comparative matrix was constructed to identify the papers with the greatest weight and reliability in the final analysis. The results of the quality assessment can be observed in Table 4, which details the scores obtained across the seven criteria (QA1–QA7) and the total score achieved (Score).

3.7 Data Extraction Strategies

In order to ensure systematic and consistent information collection, a structured strategy for data extraction was designed. This stage focused on gathering the essential elements of each included study, such as paper title, URL, publication source, year, country, ISSN, type of publication, authors, institutional affiliation, quartile, methodologies employed, abstract, and keywords. For bibliographic management, the tool Mendeley was used, which allowed for efficient organization, classification, and access to the selected references. Moreover, it facilitated the incorporation of annotations, internal searches within documents, and the preparation of summaries, thereby supporting the comparison and analysis of the different studies. Through this strategy, transparency and traceability in the handling of information throughout the entire systematic review process were ensured.

3.8 Synthesis of Findings

The studies collected to address the research questions (RQ1–RQ5) were systematically organized into tables and converted into quantitative data. This procedure enabled statistical comparisons between the different

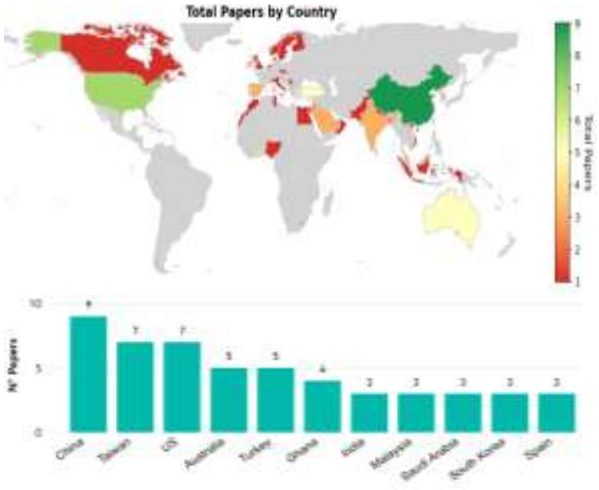

Fig. 6. Geographical distribution of published papers

approaches analyzed for each RQ. The statistical processing of the information made it possible to identify recurring patterns in the literature, as well as to recognize emerging trends and potential lines of research that have been developing in recent years.

4 Results and Discussion

This section presents the findings obtained from the systematic analysis of the 69 selected papers, organized according to the formulated research questions.

4.1. General Overview of the Studies

This subsection provides an overall view of the collected studies, highlighting their distribution according to criteria such as publication source, year, country of origin, and main areas of application, with the purpose of contextualizing the general landscape of research on the use of chatbots in higher education. In addition, Figure 4 illustrates the additional processing of the selected documents, which involved stages of selection, preprocessing, transformation, and interpretation, leading to the identification of patterns and the generation of knowledge.

Figure 5 presents the evolution of scientific production on chatbots in higher education between 2019 and 2025. This graph illustrates not only the temporal trend but also the contribution of each database to the consolidation of the field. The lower part of the figure, showing the Kendall trend, depicts the temporal behavior of scientific production on chatbots in higher education up to the first half of 2025, allowing the statistical robustness of this growth to be assessed.

The results show an incipient beginning in 2019 and 2021, with only one paper published per year. From 2022 onward, sustained growth is observed, reaching 5 papers, while in 2023 production quadrupled with 13 publications. The year 2024 represents the peak, with 30 papers mainly distributed across ARDI, ScienceDirect, and Scopus, evidencing the consolidation of the topic. In 2025, although the number decreases to 19 studies, it still reflects a level significantly higher than in the early years, indicating stability. Overall, the upward curve confirms a remarkable growth linked to the impact of generative artificial intelligence, particularly ChatGPT.

The value of $p = 0.035$ indicates a statistically significant upward trend, confirming that the increase in publications is not random but consistent over time. The adjusted polynomial equation describes in detail the evolution of the field, integrating linear, quadratic, and cubic components that explain its dynamics. The coefficient of determination ($R^2 = 0.88$) shows a high level of fit, indicating that the model explains 88% of the variability. Collectively, the findings confirm robust and statistically consistent growth, with a possible additional surge toward the end of 2025.

The results confirm an upward trend in scientific production on chatbots in education, particularly since 2016. This pattern coincides with the findings of Bensah et al. [77], who highlight progressive growth intensifying between 2020 and 2022, largely due to the impact of COVID-19. Similarly, Jiménez-García et al. [86] emphasize a notable increase since 2020 and identify 2023 as the most productive year, consistent with the findings of this review. Kuhail et al. [87] also report that more than 60% of the papers were published after 2017, with particular emphasis on the post-2020 stage, reinforcing the emerging and accelerated nature of the field. Likewise, Kuriakose et al. [88] confirm sustained growth since 2018, with significant

Table 5. Most used programming languages

Programming Languages	Reference	Qty. (%)
Python	[2] [12] [28] [46] [54-55] [62]	7 (22,5)
Java	[2] [37] [46] [48] [54] [61] [63]	7 (22,5)
C++	[65]	1 (3,3)
JavaScript	[2] [46]	2 (6,5)
R	[2] [24] [28] [31] [34] [38] [39] [43] [47] [51] [54] [58] [60] [69]	14 (45,2)

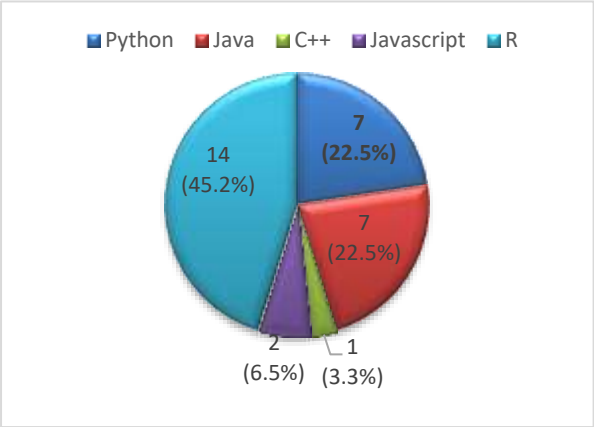

Fig. 7. Most used programming languages

peaks in 2022 and 2023, consolidating the academic interest in this line of research. Such findings are not unexpected, as there is extensive evidence linking the advancement of artificial intelligence and the educational transformations derived from the pandemic with the rise of chatbot-related studies. In this context, Wu and Yu [99] report an unprecedented increase in 2023, both in publications and citations, driven by the emergence of ChatGPT, consolidating the notion that this phenomenon has catalyzed new discussions and perspectives in higher education.

These findings indicate that academic interest in chatbots in higher education has evolved exponentially, consolidating 2024 as a reference year for scientific productivity. The diversity of sources strengthens the validity of the evidence collected and suggests a multidisciplinary field in expansion. Moreover, the relative decline in 2025 does not imply disinterest but rather a stage of research maturity. In addition, the high explanatory power of the model provides a reliable framework to anticipate future developments in the literature. Finally, this trend projects opportunities to strengthen applied research lines and develop comparative frameworks across institutional and geographical contexts.

Figure 6 shows the geographical distribution of papers on chatbots in higher education through a world map and a comparative bar chart. This representation highlights the most productive countries and regional differences in scientific output, providing a clear overview of research hotspots at the global level.China leads scientific production with 9 papers, followed by Taiwan and the United States with 7 each, consolidating themselves as research hubs in the field. Australia and Turkey reached 5 publications, showing significant participation in Oceania and Europe. Ghana and India, with 4 and 3 papers respectively, reflect an emerging interest in developing contexts. In addition, countries such as Malaysia, Saudi Arabia, South Korea, and Spain, each with 3 papers, confirm a stable presence in the field.

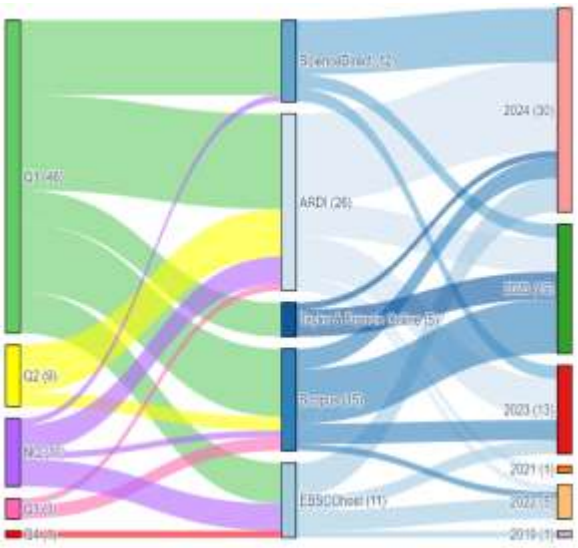

Fig. 8. Distribution of papers by quartile, source, and year

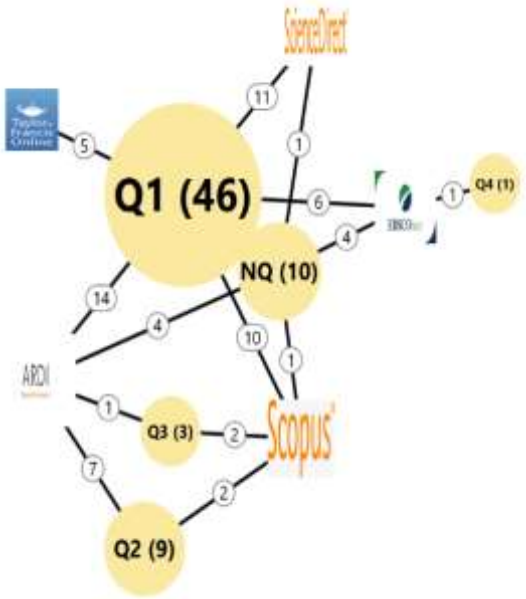

Fig. 9. Number of papers by quartile and source

Overall, the map reveals a diverse global distribution, though with a significant concentration in Asia and North America.

Among the reviewed studies, Al-Zahrani et al. [76] report that the United States leads production with 77 papers, followed by China with 36 and Germany with 24 publications. Complementarily, Polat et al. [95] highlight that the United States and the United Kingdom hold leading positions both in terms of production volume and citation impact. In line with this, Ali et al. [75] identify the United States with 22 papers, the United Kingdom and Northern Ireland with 11, and Australia with the same number of publications. In contrast, Laun and Wolff [89] indicate that Asia accounted for 63% of studies (39 papers), followed by Europe with 20.9% (13 studies), North America with 12.9% (8 studies), and Africa with 3.2% (2 studies).

Finally, Bensah et al. [77] place the United Kingdom among the most productive countries and highlight Morocco as the only African country within the top ten. Taken together, this evidence reveals a progressive diversification in scientific production, where emerging regions such as Africa, particularly Morocco, may strengthen their role through strategic international collaborations.

These results suggest that leading countries can shape the international research agenda through collaboration and knowledge transfer. The consolidation of Asia, particularly China and Taiwan, demonstrates the strategic weight of the region in educational innovation. The Americas and Europe maintain a key role in scientific dissemination, fostering global cooperation networks. Finally, the participation of Africa and the Middle East reflects a potential still in expansion, with opportunities to strengthen research in emerging local contexts.

4.2. Responses to the Research Questions

This section presents the answers to the research questions formulated, supported by the systematic analysis of the 69 selected scientific papers.

The exhaustive review allowed for the identification of significant findings regarding the role of chatbots and artificial intelligence in higher education.

These results, derived from the synthesis of empirical and conceptual evidence, provide a comprehensive view of the trends, applications, and limitations of these technologies, contributing

to the consolidation of knowledge and the strengthening of future research lines in this field.

RQ1: *What programming languages are being used for the development of chatbots?*

Table 5 and Figure 7 show the distribution of programming languages employed in the development of chatbots within higher education. This information is key to understanding the technological trends that guide the implementation of these tools across diverse academic contexts.

The results show that R is the predominant language (45.2%), reflecting its versatility in data analysis and academic environments where statistics play a central role. Python and Java present the same proportion (22.5% each), consolidating themselves as reference languages both for rapid prototyping and for scalable solutions. To a lesser extent, JavaScript (6.5%) and C++ (3.3%) appear, indicating a more specialized use in specific functionalities or integration tasks. The preeminence of R and Python suggests that educational communities value languages with robust support for AI libraries and data analysis. Collectively, the findings highlight a convergence toward languages that balance accessibility, scalability, and analytical capacity.

In the reviewed studies, Calvaresi et al. [78] report that, in a systems review, Java emerged as the predominant language, followed by Python, both recognized as among the most widely used in software development overall. In contrast, Albites-Tapia, Gamboa-Cruzado, and other authors [74] emphasize that Python is the most employed in chatbot development, a claim reinforced by Gamboa-Cruzado and his team [84, 85], who underscore its leadership in this field and consolidate the strength of their findings. Finally, Omarov, Narynov, and Zhumanov [94] broaden the perspective by noting that chatbots can also be developed in C++, Java, and Ruby, additionally highlighting the role of AIML as a key markup language for modeling natural language in these systems.

The predominance of R and Python not only impacts education but can also be transferred to sectors such as healthcare, finance, and logistics, where analytics and AI are crucial. Moreover, their open-source and cross-platform nature favors adoption in regions with more limited technological access. Looking ahead, the consolidation of Python could set the pace for expanding chatbot use across diverse global and business contexts.

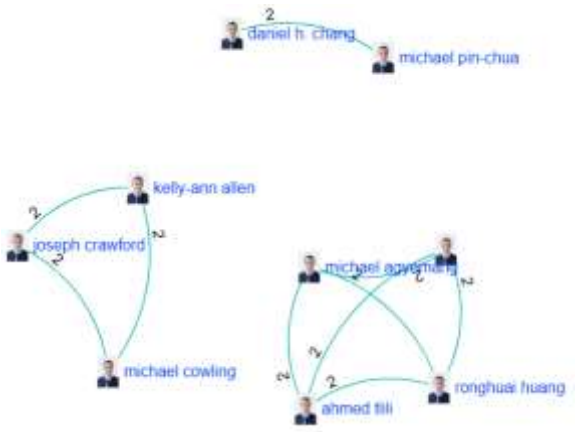

Fig. 10. Bibliometric co-authorship network

Table 6. Authors' impact

Author	No. of Papers	Total Citations	Citas/ Papers	Sum H-Index
Ahlam M. Al-Abdullatif	2	42	21	136
Ahmed Tlili	2	844	422	62
Ahnaf Chowdhury Niloy	2	35	18	73
Boulous Shehata	2	844	422	62
Daniel H. Chang	2	131	66	324
Joseph Crawfor	2	293	147	166
Kelly-Ann Allen	2	293	147	166

RQ2: *What are the quartile levels of the journals where research on the effect of chatbots in higher education has been published?*

Figures 8 and 9 respectively show the distribution of papers on chatbots in higher education according to the quartile level of the journals (via a Sankey diagram) and the connections of these categories with the main indexing sources (through a network graph). This visual representation

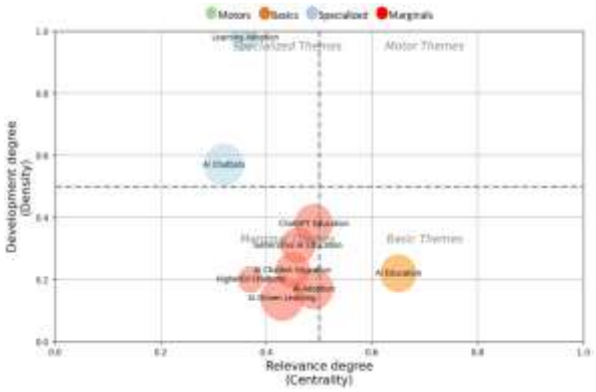

Fig. 11. Thematic map

Table 7. Thematic map categories

Theme	Density	Centrality	Total Citations	Total Papers	Category
Learning Adoption	0,98	0,36	978	15	Specialized
AI Chatbots	0,57	0,32	6141	82	Specialized
ChatGPT Education	0,38	0,49	5375	69	Marginals
Generative AI Education	0,31	0,46	4460	64	Marginals
AI Chatbot Education	0,23	0,45	4439	66	Marginals
AI Education	0,22	0,65	4841	58	Basic

makes it possible to identify the most impactful channels and the academic positioning of the scientific output in this field.

The evidence shows that the largest number of publications is concentrated in Q1 journals (46), confirming the preference for disseminating research in high-impact outlets with strong international visibility. Q2 (9) has a moderate representation, while Q3 (3), Q4 (1), and NQ (10) are marginal, revealing a pattern of concentration within the scientific elite.

The Sankey flows highlight ARDI and Scopus as the main dissemination nodes, while ScienceDirect and Taylor & Francis Online group papers primarily from higher quartiles. Likewise, the network reveals that Q1 functions as a central hub, connecting with different sources and reinforcing its role as an articulator of scientific production.

In the reviewed studies, Chamorro-Atalaya et al. [79] conducted an analysis of 92 journals, classifying them into different impact quartiles (Q1, Q3, and Q4), and also identified a group of papers without quartile assignment (NQ). Their findings emphasize that Q1 journals hold the greatest scientific relevance. Similarly, Kuhail et al. [87] found that most publications are concentrated in Q1 and Q2, highlighting their predominance in academic production. Along the same line, Nguyen et al. [93] reported that the majority of journals belong to Q1, while Q2 shows lower representation. López-Chila et al. [91] also confirmed the classification into all four quartiles, underlining that Q1 includes the top 25% of journals by impact. Finally, Flores-Velásquez et al. [82] reinforced this trend by noting that publications most frequently fall within Q1, ratifying its centrality in consolidating knowledge in this field.

The hegemony of Q1 confirms the maturity and relevance of the field, allowing the results to be extrapolated to other sectors such as healthcare, banking, and public management. At the geographical level, this concentration in well-recognized databases such as Scopus and ScienceDirect creates opportunities for institutions in emerging regions seeking greater international visibility.

The limited representation in Q3 and Q4 suggests the need to diversify publication channels, expanding the temporal and geographical scope of studies. Finally, these findings guide researchers to prioritize international collaborations and to publish in higher-impact outlets in order to maximize citation and knowledge transfer.

RQ3: *Who are the authors that frequently appear as co-authors (collaboration between groups and intra-group dynamics) in research on the use of chatbots and their influence in higher education?*

Figure 10 shows the bibliometric co-authorship network, where the dynamics of collaboration among authors are identified, revealing the existence of small interconnected groups and the strength of their ties. This analysis makes it possible to observe how academic alliances are formed and how research communities around chatbots in higher education are consolidated.

The table 6 synthesizes the academic impact of the most influential authors, assessed in terms of the number of papers, total citations, average citations per paper, and cumulative H-Index. These indicators allow for measuring not only productivity but also the quality and influence of contributions in the field of study.

The results reveal small collaboration clusters, with groups formed by authors such as Joseph Crawford and Kelly-Ann Allen, who share a high output and a considerable number of citations. Ahmed Tlili and Ronghuai Huang stand out in denser networks, reaching high citation counts (844) and solid impact indicators (H-Index 62). Daniel H. Chang, although with a smaller number of papers, possesses a cumulative H-Index of 324, which highlights his academic trajectory. The network shows that, despite dispersion, there are strategic links that strengthen collective productivity. Overall, co-authorship is concentrated in recurring pairs, consolidating reference groups in the area of educational chatbots.

In this study, it was identified that academic collaborations on chatbots in higher education are concentrated in small groups, with influential authors such as Joseph Crawford, Kelly-Ann Allen, Ahmed Tlili, and Ronghuai Huang, who stand out in both output and citation. These results are consistent with Traymbak et al. [96], who also found relevant collaboration networks, although more centralized around Meshram, Okonkwo, and Ade-Ibijola, suggesting that the concentration of links is a common feature, but with different key figures depending on the context.

Unlike Nguyen et al. [93], who argued that the most productive authors are not always part of strong networks, this analysis confirms that the researchers with the greatest impact are indeed embedded in strategic associations. Similarly, Bensah et al. [77] linked productivity with collaboration, highlighting leaders such as Konstantinidis ST and Bamidis PD; in our case, the correlation is also evident, albeit within a more dispersed network with lower-density ties. In turn, Fu, Weng, and Wang [83] described a dense network of local and international connections, while in this study the structure appears less compact, though with well-defined influential hubs. Finally, Rodríguez and Naval [98] identified a cluster in Malaysia based on institutional collaborations, a pattern that coincides with the stable ties found here, although with leading authors from other regions.

The identification of these key authors can guide future strategic alliances in other sectors such as healthcare, business management, and digital banking. Moreover, recognizing successful collaboration dynamics in Asia, Oceania, and North America opens opportunities to replicate these synergies in less represented regions. Finally, from a temporal perspective, this pattern suggests that the consolidation of international networks will be decisive for the future evolution of research on artificial intelligence applied to education.

RQ4: *What are the thematic categories addressed in research on the use of chatbots and their influence in higher education?*

Figure 11 and Table 7 present the thematic map based on keywords derived from the systematic review, where each theme is classified according to its density (degree of internal development) and centrality (relevance within the field). This analysis makes it possible to visualize the research categories surrounding the use of chatbots in higher education and their level of consolidation in the scientific literature.

The theme Learning Adoption (density 0.98; centrality 0.36) is positioned as a Specialized Theme, well-developed but with limited connections to other domains. AI Chatbots (0.57; 0.32) also appears as specialized, with the highest number of papers (82) and citations (6,141), confirming its consolidated role. On the other hand, AI Education (0.22; 0.65) emerges as a Basic Theme, highly central with 4,841 citations, which evidences its structural importance in the field despite its lower internal development. In contrast, ChatGPT Education (0.38; 0.49), Generative AI Education (0.31; 0.46), and AI Chatbot Education (0.23; 0.45) are positioned as Marginal Themes, active in terms of citations (ranging between 4,439 and 5,375) but still in the process of academic maturation. Overall, the keyword network shows a convergence between consolidated and emerging themes, articulating the evolution of the field around chatbots and higher education.

Table 8. Distribution of papers by keyword link strength

Keyword 1	Keyword 2	weight
ai	chatgpt	19
ai	chatbot	16
ai	higher education	11
chatbot	chatgpt	10
chatgpt	higher education	8
chatbot	higher education	7
chatgpt	education	5
ai	learning	5
chatgpt	education	5

In this study, AI Chatbots consolidates as a specialized theme with the highest number of papers and citations, consistent with Nguyen et al. [93], who also highlight the prominence of chatbots built on AI, machine learning, deep learning, and large language models. Complementarily, Kuriakose et al. [88] group topics such as NLP, human–computer interaction, and medical education, aspects that in our analysis are reflected in the marginal themes AI Chatbot Education and Generative AI Education, still in the process of consolidation.

Likewise, Polat et al. [95] identify research lines in AI applied to healthcare and education, with emphasis on intelligent decision-support systems, comparable to our finding of AI Education as a basic theme, highly central within the thematic network. Finally, the diversity of categories observed by Alasali, Dakkak, and Türker [73] is confirmed in this study, where both consolidated areas (such as AI Chatbots) and emerging ones (ChatGPT Education) coexist, evidencing a field in transition toward greater academic maturity.

These findings suggest that specialized themes may be extrapolated to other sectors such as healthcare or banking, where technological adoption requires rigorous validation. Basic themes, such as AI Education, offer opportunities for expansion in regions with digital gaps such as Africa or Latin America, ensuring continuity in their relevance over time. Finally, marginal themes highlight emerging research pathways that could become central axes in the future, especially with the rapid evolution of generative models and their integration into diverse business and educational contexts.

RQ5: *What keywords frequently co-occur in research on chatbots and their influence in higher education?*

Figure 12 and Table 8 present the bibliometric co-occurrence network of keywords, where the links represent the frequency with which two terms appear associated in the reviewed studies. This analysis makes it possible to identify the most influential concepts and the thematic relationships that structure research on chatbots in higher education.

The results highlight AI–ChatGPT with the highest link strength (19), confirming its central role as a conceptual core in the field. It is followed by AI–Chatbot (16) and AI–Higher Education (11), evidencing the strong connection between artificial intelligence, conversational systems, and their implementation in university settings. The Chatbot–ChatGPT (10) relationship reflects the growing integration of generative models into educational chatbots, while ChatGPT–Higher Education (8) and Chatbot–Higher Education (7) consolidate the relevance of these technologies in institutional contexts.

Additional associations such as AI–Learning (5) and ChatGPT–Education (5) demonstrate their influence on teaching and learning processes. Overall, the network shows that research focuses on the intersection of AI, chatbots, and higher education as the dominant axes of the field.

In this study, the AI–ChatGPT relationship emerges as the central node of the network (19), consistent with Wu and Yu [99], who also identified “artificial intelligence” and “chatbot” as highly frequent structural nodes. The strong associations AI–Chatbot (16) and AI–Higher Education (11) coincide with Lin and Yu [90], where these terms were positioned as strategic interconnectivity hubs. Complementarily, the links Chatbot–ChatGPT (10) and ChatGPT–Higher Education (8) reinforce the importance highlighted by Kuriakose et al. [88], emphasizing the role of technical and human clusters in chatbot-mediated education. Finally, secondary connections such as AI–Learning (5) and ChatGPT–Education (5) correspond to Fu, Weng, and Wang [83], who emphasized artificial intelligence and machine learning as organizers of the research agenda.

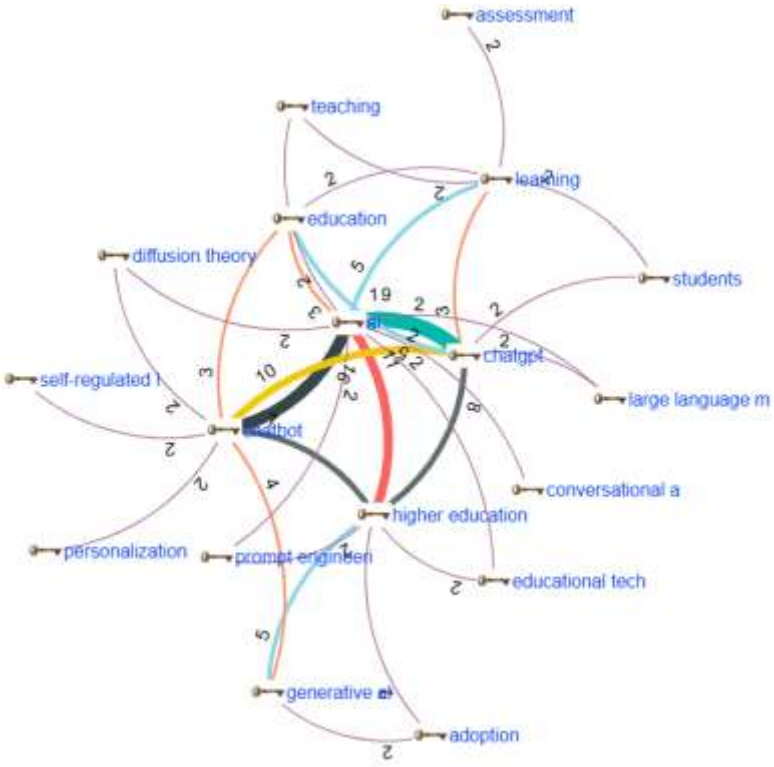

Fig. 12. Bibliometric keyword network

These findings suggest that the articulation of AI and chatbots not only impacts higher education but can also extend to sectors such as healthcare, finance, and commerce, where machine learning and personalization are critical. At the geographical level, emerging regions could benefit from these synergies as a strategy to accelerate digital transformation. From a temporal perspective, the detected co-occurrences anticipate that the integration of generative models will continue to shape the research agenda in the coming years.

5 Conclusions and Future Research

First, regarding RQ1, the results show that the predominant programming languages in the development of educational chatbots are R, Python, and Java, reflecting a clear convergence toward environments with strong support for statistical analysis and machine learning. This trend not only responds to the need for robust and scalable solutions in academia but also demonstrates how research communities prioritize open, versatile languages with mature ecosystems.

Second, when analyzing RQ2, it is observed that most studies have been published in Q1 journals, confirming the degree of maturity and visibility achieved by the field. This concentration in high-impact outlets demonstrates that the debate on chatbots in higher education has gained ground in leading academic forums, consolidating its scientific relevance and influence in shaping innovative pedagogical policies and practices.

Complementarily, in relation to RQ4, the thematic map constructed from keywords reveals that research is structured around categories such as AI Chatbots and AI in Education, consolidating as basic axes, while emerging themes such as Generative AI in Education and ChatGPT in Education are still in the process of consolidation. This distribution suggests that the field combines

mature areas with new lines of inquiry, fostering a dynamic and continuously evolving ecosystem.

Similarly, findings linked to RQ5 show that the most frequent co-occurring keywords are AI, ChatGPT, and Chatbot, reinforcing the centrality of these concepts in recent academic literature. The high frequency of associations between artificial intelligence and higher education confirms that the research discourse is centered on the integration of conversational AI into university environments, both in its technological dimension and in its pedagogical implications.

Taken together, these four RQs demonstrate that the use of chatbots in higher education has shifted from being a marginal issue to consolidating itself as a central area of research at the intersection of technology and pedagogy. The diversity of programming languages, the high quality of publications, the thematic structuring, and the centrality of key keywords reflect an expanding field that is rapidly adapting to advances in generative AI and changes in teaching–learning processes.

The scope of this study was limited exclusively to journal articles and conference papers, prioritizing publications from scientific journals. Other sources, such as theses, were excluded, and only English-language papers were collected. This could restrict the diversity of perspectives and approaches represented in the analysis.

Future research should deepen the comparative analysis of the impact of different programming languages on the efficiency of educational chatbots, explore adoption in institutional contexts with lower technological development, and broaden the longitudinal scope to evaluate how thematic categories and keyword co-occurrences evolve over the next decade.

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