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# Artificial Intelligence in Economics Education: Research Trends, Scientific Activity, and Future Directions

**Angelos I Stoumpos[1]*, Rodanthi I Stoumpou[2], Michael A Talias[3] and Vassilis Tsiantos[4]**

[1]*Science Teaching and Modern Technologies, Interdepartmental Postgraduate Program, Democritus University of Thrace (DUTH), Kavala Campus, Kavala, Greece, https://orcid.org/0000-0001-7080-888X*

[2]*School of Pharmacy, Faculty of Health Sciences, Aristotle University of Thessaloniki (AUTH), Thessaloniki Campus, Thessaloniki, Greece*

[3]*Healthcare Management Postgraduate Program, Open University Cyprus, Nicosia, Greece, https://orcid.org/0000-0002-1802-5586*

[4]*Science Teaching and Modern Technologies, Interdepartmental Postgraduate Program, Democritus University of Thrace (DUTH), Kavala Campus, Kavala, Greece, https://orcid.org/0000-0001-6317-4284*

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***Corresponding author:** Angelos I Stoumpos, Science Teaching and Modern Technologies, Interdepartmental Postgraduate Program, Democritus University of Thrace (DUTH), Kavala Campus, Kavala, Greece

## Abstract

The rapid integration of artificial intelligence tools into the educational process is radically transforming economic education, affecting not only learning outcomes, but also pedagogical approaches themselves. These technologies allow for the development of personalized learning experiences, automated assessment, and more dynamic understanding of complex economic concepts. This study presents a systematic literature review, aiming to map the main trends, challenges, and existing research gaps regarding the application of artificial intelligence in economic education. The review is based on data extracted from the Scopus database, covering the period 1986–2024. The search was conducted in December 2024, identifying 433 publications, of which 131 met the inclusion criteria for further qualitative and quantitative analysis. The bibliometric approach was supported by the use of VOS viewer software, which contributed to the identification of thematic areas, research correlations and gaps in the international literature. The findings of the study highlight both areas of high research activity and areas that remain limited, offering suggestions for future interdisciplinary research.

**Keywords:** Artificial Intelligence (AI); Smart systems; Economics; Teaching; Didactic; Technology; Education

## Introduction

Educational teaching is increasingly transforming at a rapid pace, deeply influenced by developments in technology. Technology, and in particular the evolution and utilization of Artificial Intelligence, is part of the broader digitalization of education. Digital educational transformation plays a particularly important role in the way we approach teaching. Especially in subjects such as economics. It is therefore a scientific field that is based not only on abstract theories, but also on rigorous mathematical models and quantitative analysis. This is why this particular teaching becomes demanding for all those involved. In this context, artificial intelligence is a valuable tool. Its ability to process, in addition to huge volumes of data, and to personalize the learning experience, while simulating complex situations, can provide solutions to many of the problems faced by teachers. Furthermore, it can contribute to improving learners' understanding and overall improving the quality of the educational process.

Smart systems technologies such as machine learning, natural language processing, and data analytics are already being applied in various areas of economics education, from creating interactive learning platforms to providing real-time feedback on student performance [1]. One of the most important benefits of artificial intelligence in teaching economics is its ability to deliver personalized learning experiences. By analyzing a student's performance, smart systems can tailor the curriculum to individual needs, helping to clarify difficult concepts and provide targeted resources where needed [2]. In addition, artificial intelligence-powered simulations and modeling tools allow students to experiment with real-world economic scenarios, deepening their understanding of economic principles and the complexity of global markets [3].

But beyond personalization, this kind of technology can facilitate even more effective and engaging ways of teaching economic theory. For example, basic supply and demand models, but also more complex concepts, such as game theory. One of the capabilities of artificial intelligence is the processing and visualization of large data sets, which facilitates students and participants in both empirical research and economic forecasts [4]. Artificial intelligence, in this way, is able to bridge the gap between theoretical knowledge and practical application. This is therefore a critical aspect when it comes to teaching economic, especially in an increasingly data-driven world.

However, integrating Artificial Intelligence (AI) into economics education is not without challenges. There are concerns about accessibility, the need for educators to develop new pedagogical strategies, and the potential for overreliance on technology [5]. Furthermore, the ethical implications of using artificial intelligence-particularly with regard to data privacy, algorithmic bias, and the role of the teacher—need to be carefully considered [6].

Although this study focuses primarily on the use of artificial intelligence in economic education, it is important to recognize the great potential of digital technologies in finance. More specifically, digital technologies, including artificial intelligence, can help in modeling complex phenomena, such as structural estimations [7], state-contingent claims [8], and Monte Carlo simulations, in discrete and continuous time [9].

In conclusion, the manuscript incorporates elements of a systematic literature review, it also offers a critical narrative analysis, as well as a broader discussion on the applications of artificial intelligence in economic education. This is why it is categorized as a research article, rather than a pure systematic review. There are several unanswered questions, which are related to a number of issues, such as the effectiveness, ethical dimensions and applications of artificial intelligence in the teaching of economics. For this reason, this study explores the following questions: (1) What are the main trends and research areas regarding the use of AI in economics teaching? (2) How has scientific activity evolved and what are the geographical and thematic distributions in research on AI in economics education? (3) What are the main research gaps and what directions are suggested for future research? Unlike previous studies that focus fragmentarily on the applications of AI in education, the present study offers a comprehensive bibliometric analysis of the field, identifying the main themes, emerging research hotspots and future research directions. Particular emphasis is placed on mapping thematic clusters through co-occurrence analysis and on utilizing PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) for transparency of methodology.

The following chapter provides the fundamental framework for a better understanding of the theoretical background and recent advances in artificial intelligence applications for economic and financial education. This section is included to ground the systematic review in current research trends and highlight key issues shaping the analysis.

## Economic teaching methods exploiting artificial intelligence in education

The adoption and use of artificial intelligence in economics has gained momentum, offering not only innovative ways to improve learning experiences, but also contributing to the optimization of both teaching and learning outcomes. Furthermore, it is able to be integrated into various aspects of economics education, from personalized learning experiences to real-time data analysis, providing not only new opportunities for students themselves, but also for educators. Below are some key areas where artificial intelligence can be utilized in economics teaching:

### Personalized Learning

Intelligent systems can create adaptive learning environments. They achieve this by responding to the individual needs of learners. By analyzing the progress, learning styles, and strengths of learners, artificial intelligence can suggest personalized learning paths. Adjusting content difficulty and pace accordingly. For instance:

- Intelligent Tutoring Systems (ITS): These artificial intelligence - driven platforms can provide immediate feedback and explanations to students, helping them understand economic concepts at their own pace [10]. For example, platforms like Khan Academy and ALEKS have utilized artificial intelligence to offer personalized tutoring, which has been shown to improve student outcomes [11].

- Learning Analytics (LA): AI can assess students' performance and behavior in real time, offering insights into areas where they might be struggling and providing resources to target these weaknesses [12]. Through the use of learning analytics, educators are able to monitor student progress and modify teaching strategies, thereby improving the learning experience.

### Data - Driven Insights for Students

Economics is fundamentally reliant on data, and artificial intelligence technologies are progressively utilized to assist students in examining extensive datasets and obtaining insights that streamline intricate economic models.

- Understanding Complex Models: Machine learning algorithms and smart systems - driven data visualization tools assist students in understanding complex economic models by segmenting extensive datasets into digestible parts [13]. Platforms like Tableau Software and R (R Project for Statistical Computing) allow for dynamic visualizations that help students explore relationships between variables in economic models.

- Simulation of Economic Scenarios: Artificial Intelligence can replicate real-time economic situations that allow students to test macroeconomic strategies or grasp market dynamics. These


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simulations can assist in grasping ideas such as supply and demand, market equilibrium, and game theory [14].

### Interactive Learning Tools

Artificial Intelligence - powered tools are revolutionizing conventional classroom environments by establishing interactive learning spaces like virtual labs, simulations, and game-based educational experiences.

- Economic Simulations: Artificial Intelligence models can simulate entire economies, allowing students to apply theoretical knowledge in a practical, dynamic setting [15]. For instance, EconLand and MarketSim allow students to test policies and analyze economic phenomena such as inflation, unemployment, or market competition.

- Gamification: Smart systems - powered economics games, such as SimCity or Capitalism II, help students engage with economic principles like resource allocation and trade-offs in an enjoyable and immersive manner [16]. These games offer an experiential learning process where students can make decisions based on real-world economic theories.

### Automated Grading and Feedback

Artificial intelligence systems can automate both the grading of assignments, quizzes or exams, thus freeing up instructors' time to focus on more personalized aspects of teaching.

- Automated Assessment: Artificial Intelligence can quickly and accurately grade multiple - choice, short-answer, and even essay questions [17] This is especially valuable in large economics courses where grading can be time-consuming. Studies suggest that AI-based grading systems like GradeScope offer efficient and accurate assessment for economics students.

- Peer Review Systems: Artificial Intelligence can assist in peer evaluation by analyzing the quality and consistency of student feedback in collaborative learning environments [18]. This not only saves instructors time but also promotes more thoughtful and constructive feedback from students. On the one hand, according to Kankanhalli [19], due to the increasing volume of submissions and the limited resources of reviewers, there is an urgent need to use artificial intelligence to improve the efficiency of academic peer reviews [19]. On the other hand, Xu et al. [20] claim that there are growing concerns about the use of artificial intelligence, including ethical questions and issues such as hallucinations [20].

### Natural Language Processing (NLP) in Teaching

Smar systems - driven Natural Language Processing (NLP) tools can assist students in analyzing complex economic texts, from academic papers to news articles, helping them interpret technical jargon or summarize key points.

- Text Analysis: Natural Language Processing (NLP) tools like IBM Watson and Clarabridge - Qualtrics enable students to extract key insights from large volumes of economic literature [21]. Artificial Intelligence can also identify emerging trends, economic indicators, and essential data points that are often buried within large reports.

- Language Translation: Artificial Intelligence - powered translation tools, such as Google Translate, allow students from diverse linguistic backgrounds to engage with economics content more effectively [22].

### Artificial Intelligence (AI) for Research Assistance

AI tools can significantly aid economics students and researchers in processing large datasets, detecting trends, and conducting thorough literature reviews.

- Data Analysis: Machine learning models help students analyze economic data, detect patterns, and predict trends. Tools such as R, Stata, or Python can be integrated into artificial intelligence - driven platforms to enhance the research experience [23].

- Literature Review: Artificial Intelligence algorithms can scan large databases of academic literature, identify relevant research papers, and synthesize key findings. This accelerates the literature review process and helps students stay updated with the latest developments in economics [24]. While we expect that more advanced Large Language Models (LLMs) will improve this problem, due to the inevitable risk of hallucinations, researchers and students should be particularly careful with the synthesis of literature produced from such sources [20].

- AI-Driven Financial Simulations: Artificial intelligence technologies are significantly enhancing financial education, helping to improve the accuracy and accessibility of advanced technical simulations. One of the most important potential applications is in Monte Carlo simulations, which model the behavior of financial systems over time. Although they are often considered so-called "black boxes," such simulations can be improved by artificial intelligence. The latter provides more realistic approximations of distributional properties with fewer computational resources. This allows educators to better illustrate dynamic economic concepts, such as security pricing [8], consumer behavior, and firm-level decision-making [9]. Additionally, AI technology can mimic structural estimation processes, allowing learners to explore economic models under different dynamic demands [7]. Such techniques are considered fundamental in finance education, allowing for the visualization of risk dynamics and the assessment of policy implications. Integrating AI-driven simulations into the curriculum can deepen students' understanding of real-world economic decision-making. This in turn strengthens the analytical skills necessary to interpret stochastic processes.

### Virtual Teaching Assistants (VTA)

Artificial Intelligence - powered virtual assistants can assist both students and instructors by answering questions, providing



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guidance, and managing administrative tasks.

- Artificial Intelligence Chatbots: Artificial intelligence chatbots such as ChatGPT or Replika can answer learners' questions about economic theories or provide clarifications or even suggest additional learning resources [25]. These assistants can simulate tutor-like interactions, enhancing student engagement.

- Course Management: AI tools help manage scheduling, grade distribution, and assignments, offering instructors a way to automate administrative tasks and focus more on student engagement [26].

### Collaborative Learning Platforms

As for Artificial Intelligence, it can enhance collaborative learning. It can achieve this by strengthening relationships between students with shared learning interests or even by providing complementary skills, while contributing to the creation of a dynamic learning environment. An environment that encourages teamwork and knowledge sharing.

- Smart Grouping: Artificial Intelligence can intelligently group students. Either based on their strengths and weaknesses, or learning styles. In either case, it strengthens the team's dynamics and improves overall problem-solving [27].

- Discussion Platforms: Smart systems-powered discussion forums can suggest relevant topics, resources, or even guide discussions, fostering deeper engagement with economics content [28].

### Economic Forecasting and Modeling

AI 's predictive capabilities can assist students in understanding and creating economic forecasts using real-time data.

- Predictive Models: Artificial Intelligence can analyze historical data and generate predictions related to key economic indicators such as Gross Domestic Product (GDP) growth, inflation rates, or employment trends [23]. These models help students understand the potential impact of economic shocks or policy changes.

- Modeling Economic Policies: Artificial Intelligence-based platforms, such as EViews or MATLAB, allow students to simulate the effects of different economic policies. In this way, they contribute to students' testing of various fiscal or monetary interventions [29].

### Enhancing Online and Hybrid Learning

Intelligent systems can play a critical role, not only in improving efficiency, but also in online and hybrid learning environments. In this way, they will contribute to a more interactive and engaging education delivery.

- Adaptive Content Delivery: Artificial Intelligence systems can provide personalized content. This can be achieved either based on the needs of each student, or by ensuring that online courses are more interactive and flexible [12].

- Virtual Classrooms: Smart systems enhance the functionality of virtual classrooms, enabling real-time feedback, quizzes, and even interactive lectures that mimic in-person teaching experiences [30].

Artificial intelligence can be applied to economic education, offering great possibilities for personalized improvement, interactivity and quality of learning. Examples of the use of such technologies are virtual simulations and intelligent teaching systems. By leveraging new technologies, educators are able to offer not only new but also exciting educational experiences. However, in order to properly use artificial intelligence to its fullest, it is equally important to address certain issues, such as privacy and data security.

The analysis of the above methods lays the foundation for our study on the bibliometric mapping of the main thematic areas of artificial intelligence in economic education, which follows in the next section.

## Methodology

We took a systematic approach to conduct a comprehensive bibliometric analysis of the impact of artificial intelligence (AI) on the teaching of economics. Our process involved the following steps:

### Data Collection – Extraction and Selection

We derived data the December 24, 2024, from the Scopus database, which is recognized for the extensive coverage of literature and strict peer-reviewed indexing standards [31]. This platform ensures high scientific validity and extensive coverage of our scientific field. In addition, it provides access to qualitatively selected journals. In this way, the scientific integrity of the information obtained is ensured.

Unlike other databases such as Web of Science and ScienceDirect, the Scopus platform provides, as mentioned above, broader coverage of scientific journals from many publishers and covers more fields, which ensures a more comprehensive review of the literature. In addition, this platform is frequently updated, providing updated data and statistical analysis tools that strengthened our study process.

We limited our search to articles published from 1986 to 2024 to capture fundamental studies and recent developments in the field. This extended time frame allowed us to observe trends over time, offering insights into the evolution of artificial intelligence in teaching in courses or subjects of economic sciences.

After identifying relevant articles, we used a combination of specific keywords to extract data from titles, abstracts and keyword sections. Table 1 presents the research strategy of the study with the search base and the keywords we used. The search was performed in the Scopus database using the following search queries: (teaching OR didactic) AND (economic OR economics) AND


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(artificial intelligence). This targeted approach has allowed us to focus on study articles that directly contribute to the intersections of our primary research interests.

**Table 1:** Search Strategy.

| Database | Search within | Keywords | No Sources |
|---|---|---|---|
| Scopus | Article title, Abstract, Keywords | (teaching or didactic) AND (economic or economics) AND (artificial intelligence) | 433 |

## Inclusion Criteria

In this study, exclusively articles published in scientific journals and written in English were selected, as illustrated in (Figure 1). This selection was made with the aim of ensuring the academic credibility of the sources, since English is used internationally by a large part of the scientific community. In addition, English journals may reflect higher standards of evaluation and editorial process, compared to, for example, books or conference proceedings.

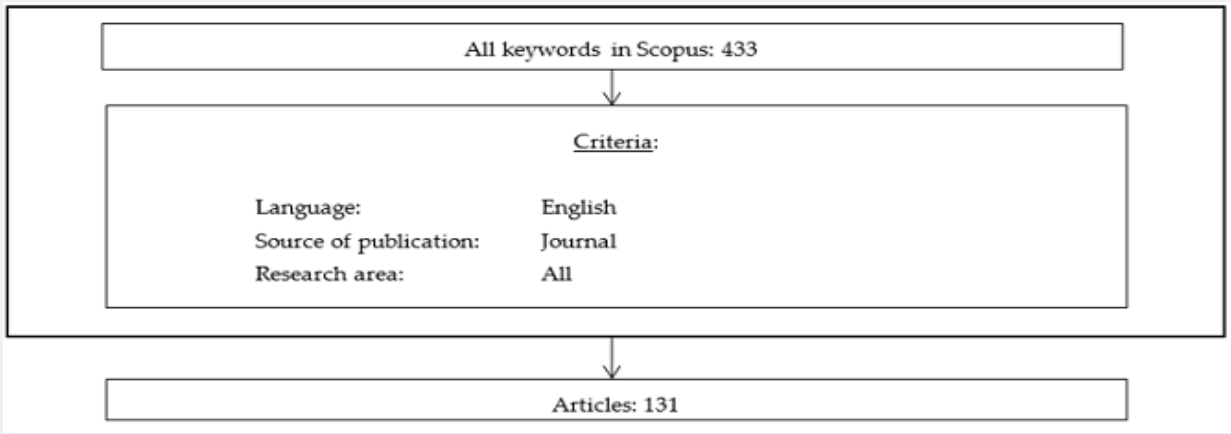


**Figure 1:** The diagram for the first phase of the selection process.

Our initial search includes 433 articles, which cover a wide range of thematic areas and scientific fields. However, we adopted specific selection criteria in order to ensure both the relevance and the quality of the contents that would be included in our analysis.

After applying the above criteria, the initial set was limited to 131 journals, for conducting our analysis.

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) analysis is an established protocol used for transparent and systematic presentation of the methodology and results of a systematic review or meta-analysis [32]. The PRISMA model includes a flow diagram (PRISMA Flow Diagram) that describes in detail the process of selecting studies, from the initial search to their final inclusion in the analysis [33].

According to the systematic literature review, we followed the standards proposed by Webster and Watson (2002) for the selection and rejection of articles [34]. Our process included multiple stages of evaluation, in order to ensure the accuracy and completeness of the data collection.

Initially, we identified 131 articles through a search in a reputable database (Scopus), without setting a time limit on the results obtained. The search was carried out using targeted keywords. In the first stage, we evaluated the titles of the articles based on their relevance to our research topic. In this phase, 2 articles were rejected, as they were not directly related to the application of artificial intelligence in economic education.

In the second stage, we proceeded to read the abstracts of the remaining 129 articles. In this phase, articles were rejected that:

- Did not focus on pedagogical applications of artificial intelligence.
- Referred to technical aspects (e.g. algorithm development) without relevance to teaching.

Subsequently, access to the full text of the articles was attempted. However, 58 articles were rejected because:

- They were not available in full text or were intended for internal use.


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In the last stage, duplicate entries were rejected, resulting in the final sample consisting of 70 articles, which represent a critical set of publications covering the most important trends and conceptual developments in the field of artificial intelligence in economic education. Figure 2 summarizes the process of selecting and excluding articles.

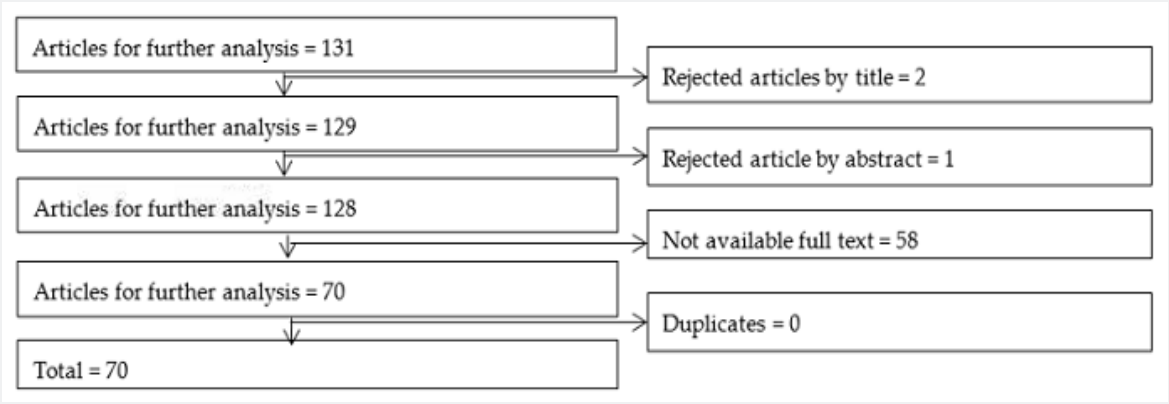


**Figure 2:** Article selection process.

In order to ensure methodological completeness, the selection of articles was carried out based on the following inclusion criteria:

1. Thematic relevance: We examined articles that directly link artificial intelligence to economic education.

2. Peer-reviewed: We included only articles that have undergone rigorous evaluation.

3. We included the entire chronological range, up to the date our search was implemented, in order to capture all trends.

The application of the methodology of Webster & Watson [34] allowed us to identify a representative sample of the scientific literature, ensuring systematicity and objectivity in the data collection process [34].

### Data Processing and Analysis

The collected data was processed using bibliometric tools such as VOSviewer v.1.6.20 (a software developed by Van Eck and Waltman), which allows advanced analyses of referral networks, co-authoring templates, keyword co-occurrence and research trends [35]. We selected this tool for its capabilities in visualizing complex networks and identifying important research topics and collaborations.

### Keyword Co-occurrence Analysis

Keyword co-occurrence analysis is the process of identifying and analyzing the frequency of keywords. Keywords appear either in a given text or in a set of texts [36]. It is most commonly used in fields such as text mining, information retrieval, and Natural Language Processing (NLP). It helps uncover the relationships between terms and understand the context or topics of a document, article, or corpus.

### Co-authorship and Collaboration Networks

With the mapping of the networks of co-authors, we observed important writers and institutions and international trends of cooperation in the research of teaching and didactic of economics through artificial intelligence. The co-authorship network explains how authors have been associated with each other from various fields of research based on their published articles. The network is considered one of the most credible and concrete methods for describing the author's collaborations [37].

### Citation Analysis

This approach helped us identify the most cited articles and magazines, highlighting the creative work that has shaped the field [38]. Through citation analysis, it is possible to assess not only the degree of influence of a scientific work, but also of an author or article. According to the number of citations it has received. At the same time, this method facilitates the detection of important or pioneering studies that shape the research field.

The next section presents the findings of the bibliometric analysis, revealing the main trends and research gaps.

## Results

This chapter presents the research findings, which arise from the bibliometric analysis and the study of the data. The results are systematically analyzed, with the aim of revealing the main trends, thematic units and research relationships that arise from the use of artificial intelligence in economic education.

Particular emphasis is placed on the presentation of the main axes of the research. As well as on the geographical and thematic distribution of the studies. In addition, the existing research gaps are examined. The results of the research provide a comprehensive picture of the scientific landscape. Offering valuable information both on current developments and on future directions of research.


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Our search included 131 articles, with an increasing trend in the number of publications over the years.

## Quantitative Analysis

The oldest articles date from 1986. On the contrary, during the time periods 1987-1993, 1995-1999, 2001-2004, 2006-2008 no articles were published at all. As well as the years 2010 and 2013. While, since 2015, a steady increase in publications has been observed. These publications focus primarily on the application of artificial intelligence as an educational method. But also, as a process in economics courses. Figure 3 depicts the annual number of published articles in combination with the annual number of citations. An upward trend in the volume of citations is evident from 2015 onwards. However, while the annual number of articles is increasing, the number of citations fluctuates. Recording an exponential increase between the years 2015 and 2024.

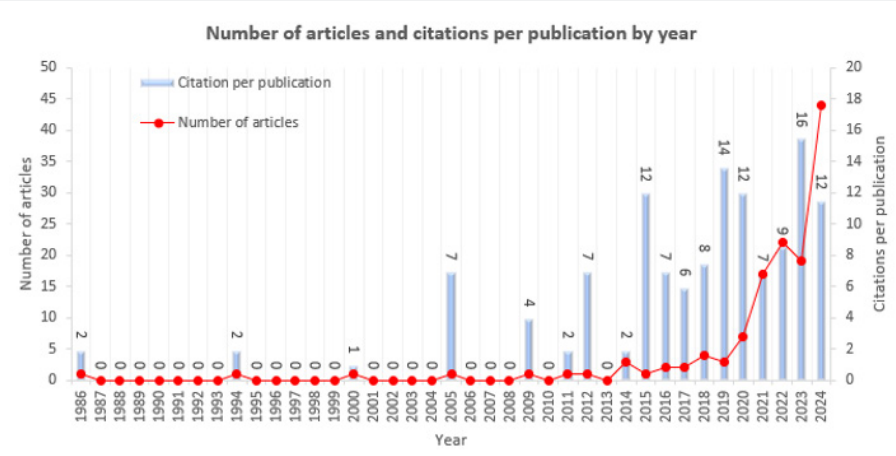


**Figure 3:** Number of articles and citations per publication by year.

The following (Figure 4) shows the distribution of articles by subject category. It shows that "Computer Science" holds the largest share, constituting 22% of all articles. This fact underlines the important role of technological advances, but also of digital research, not only at the academic, but also at the professional level.

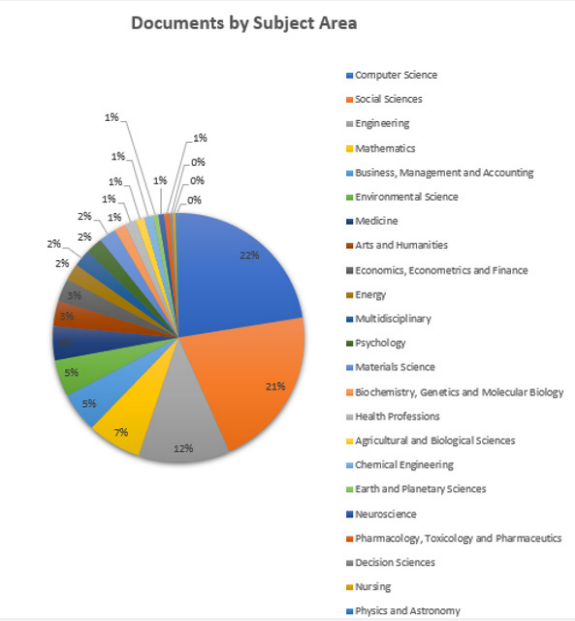


**Figure 4:** Documents by subject area.

The second largest percentage is held by the "Social Sciences", with 21%. This high percentage reflects the growing interest in human behavior, society and studies related to politics. The importance of this high percentage also outlines the challenges that social research is called upon to face today.



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The third highest percentage is followed by the field of "Engineering" with 12%, demonstrating the continuous innovation and problem-solving approaches in this field. Then, "Mathematics" makes up 7%, highlighting its fundamental role, not only in theoretical, but also in applied research, such as data science, quantitative analysis and cryptography.

As for the remaining thematic areas, they each account for less than 5%. However, although these percentages may be considered low, they should not be underestimated, in any case, because they contribute valuable knowledge to the scientific community. The current distribution and their interconnections reflect research trends and highlight the dynamic nature of the disciplines.

Table 2 lists the sixteen top institutions that have contributed the most articles to the study of artificial intelligence in economic education. We observe, according to the table, that each of these institutions has published at least two articles. This reflects their significant involvement in the field. However, there are notable differences when analyzing the data by country. The distribution of the research output is geographically diverse. With contributions from different regions around the world.

**Table 2:** Documents per Organization.

| Documents per Organization | | |
|---|---|---|
| **Country** | **Organization** | **No. of publication** |
| Australia | Monash University | 2 |
| Australia | The University of Sydney | 2 |
| China | Beihang University | 2 |
| China | Hebei Agricultural University | 2 |
| China | Hebei Finance University | 2 |
| China | Henan University of Engineering | 2 |
| Iran | University of Tehran | 2 |
| Philippines | De La Salle University | 2 |
| Russian Federation | HSE University | 2 |
| Russian Federation | The State University of Management | 2 |
| Saudi Arabia | King Abdulaziz University | 2 |
| Spain | Universidad de Salamanca | 2 |
| Spain | Universidad Rey Juan Carlos | 2 |
| Spain | Universitat de Barcelona | 2 |
| Spain | Universitat de València | 2 |
| Thailand | Mahidol University | 2 |

- Iran, Saudi Arabia, Philippines, and Thailand are each represented by one institution. This highlights the growing interest in artificial intelligence in different regions.

- China and Spain hold the lead in research, both for artificial intelligence and for economic education. On the one hand, China is particularly influential, as it lists four institutions with prominent contributions: Beihang University, Hebei Agricultural University, Hebei University of Economics and Henan University of Engineering. Collectively, these institutions account for a large part of the publications in this field. While, on the other hand, Spain also leads with four institutions: the University of Salamanca, the Rey Juan Carlos University, the University of Barcelona and the University of Valencia.

These eight institutions (four from China and four from Spain) represent the largest number of publications in the field, signaling strong academic interest and institutional support for artificial intelligence integration into economics education.

The distribution of publications by country reveals notable trends in artificial intelligence research across different regions:

- China tops the global rankings with 44 articles. Thus, demonstrating its role as a major hub for AI research in economic education. This increased number is likely due to China's significant investments in AI technology. It may also be due to its increasing focus on digital education or data-driven research methodologies.

- United States of America (USA) follows with 16 articles, reflecting ongoing research activities in artificial intelligence applications within education, particularly in higher education institutions.

- Spain contributes 10 articles, demonstrating the country's growing interest in applying artificial intelligence to economics and education.

- Russia and the United Kingdom each have 7 publications, showing active but relatively smaller contributions compared to China and the United States of America (USA).



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- Other countries, such as France, Egypt, and New Zealand, have published one article each. This indicates their emerging interest or any specialized contributions in the field.

Figure 5 shows the number of publications by country. China is clearly at the top, followed by the United States of America (USA) and Spain. This distribution highlights the global spread of research on artificial intelligence applications in economic education. Research with notable contributions from both developed and developing countries.

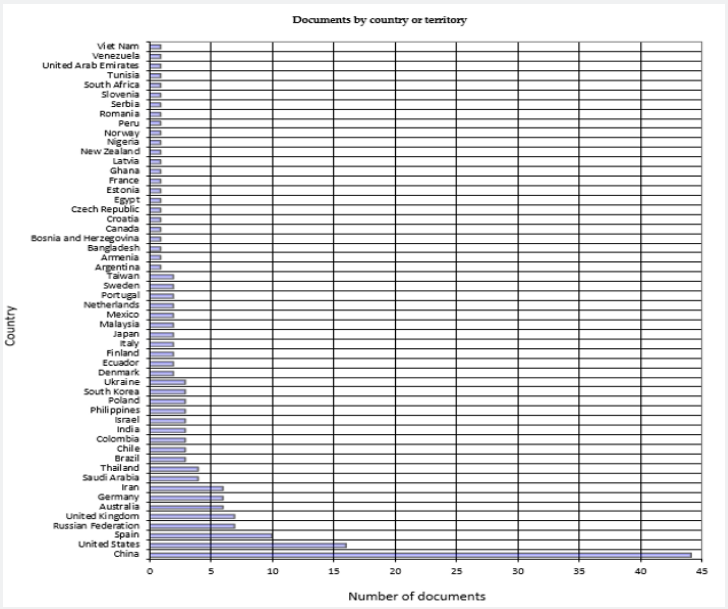


**Figure 5:** Countries by the number of publications.

## Keyword Co-occurrence Analysis

This chapter focuses on keyword co-occurrence analysis, a method that allows for understanding the main thematic areas and research trends in a scientific field. Through this analysis, the most frequently used terms and the relationships between them are identified, revealing the central research interests and thematic connections. The study of these relationships contributes to mapping the scientific landscape and identifying critical areas for further research.

Figure 6 represents a grid that focuses on the keyword reproduction within the literature on the general dimensions of teaching economics through artificial intelligence. This grid illustrates the interconnectedness between artificial intelligence, economics, and teaching, revealing how these core themes are prevalent throughout the literature.

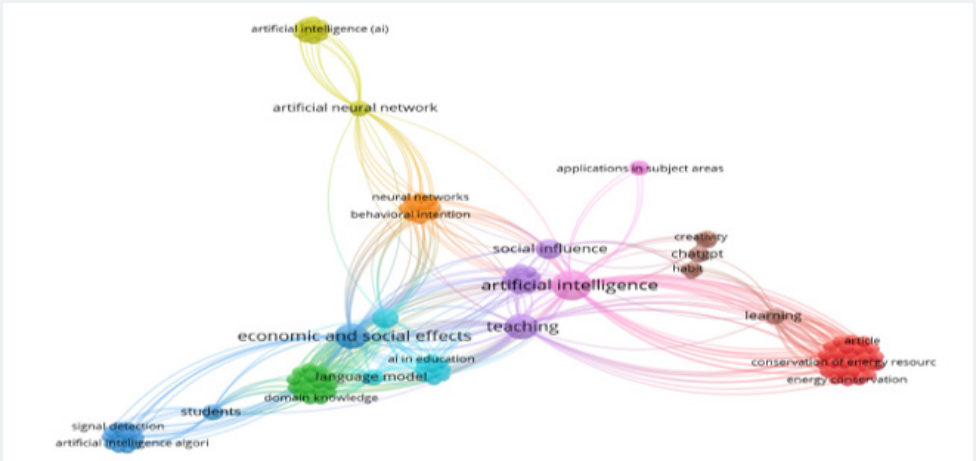


**Figure 6:** Network analysis.



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Artificial Intelligence is clearly central, acting as the primary tool or concept through which changes in economics education are being explored. This highlights the growing role of artificial intelligence in reshaping teaching methodologies.

Economics and Teaching are closely linked, underscoring the integration of artificial intelligence into pedagogical approaches designed to improve the learning and understanding of economic principles.

Additional keywords that may appear on the grid include terms like machine learning, personalized learning, data analytics, and econometrics, each representing critical dimensions of AI 's application in economics education.

Figure 7 presents the network analysis of keywords related to the publication timeline. The analysis allows us to visualize how different keywords have evolved in prominence over time.

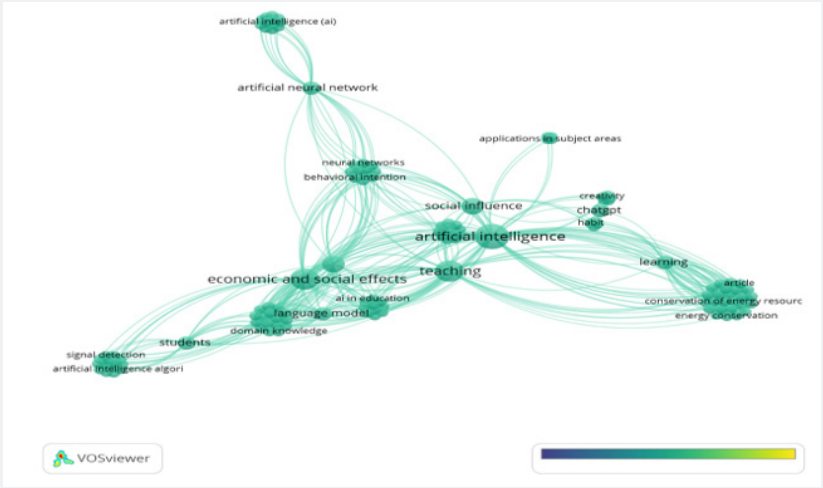


**Figure 7:** Evolution of the network over time.

Yellow indicates more recent keywords, which likely correspond to emerging trends or technologies in artificial intelligence and economics education that have gained traction in the last few years.

Dark Blue represents older keywords, which could correspond to initial artificial intelligence applications in education or more traditional economic concepts, such as economic theory, that have been integrated with newer artificial intelligence technologies over time.

This color-coded timeline offers insights into how the research landscape has evolved, with newer concepts like ChatGPT and artificial intelligence in education growing in importance. The absence of yellow in the figure suggests that these newer keywords have not yet fully saturated the literature but are likely gaining momentum. Meanwhile, the green nodes represent, foundational artificial intelligence terms that set the stage for contemporary developments.

Figure 8 shows the density visualization map of keywords, providing a spatial representation of the most prevalent nodes or concepts in the literature on artificial intelligence in economics education.

- Artificial Intelligence and Teaching emerge as dominant nodes, underscoring the dual focus of this field on technological innovation and its application to educational methodologies.
- Economic and Social Effects reflect the growing interest in understanding how artificial intelligence impacts broader economic and societal outcomes, especially in terms of how students learn and engage with economic content.
- Energy Conservation appears as a related theme, indicating that artificial intelligence tools may also be examined for their role in promoting sustainability or energy-efficient learning environments.
- Artificial Intelligence (AI) in Education as a keyword is highly prevalent, showcasing the expansion of artificial intelligence beyond economics into broader educational contexts, signaling that AI's application in teaching is gaining traction across disciplines.
- ChatGPT is another prominent keyword, signaling the increasing focus on artificial intelligence - driven conversational agents and their role in interactive, personalized learning environments for economics students.

This visualization map reflects how AI 's use in teaching economics is becoming more multifaceted, with increasing emphasis on both educational and societal dimensions. It also reveals the interplay between artificial intelligence technology and various fields of application within economics education.


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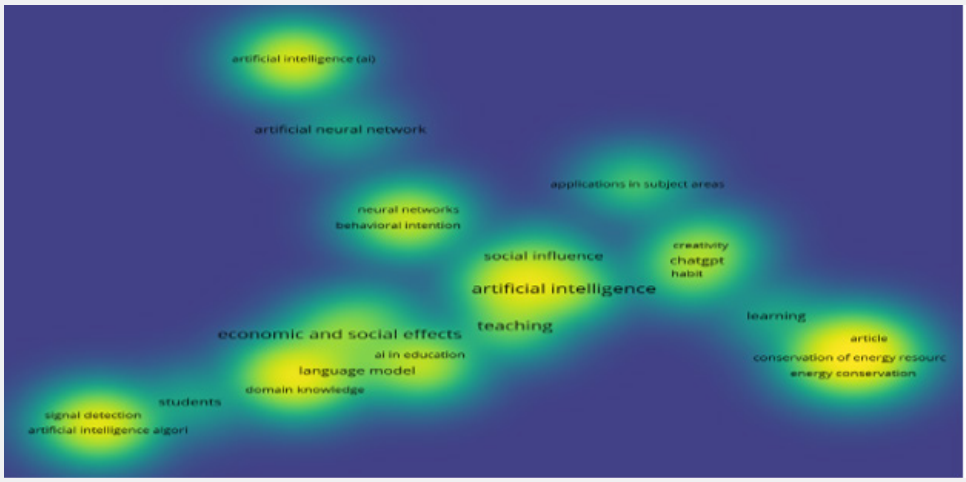


**Figure 8:** Density Visualization Map of Keywords.

The most relevant keywords are listed in (Table 3). Keyword co-occurrence analysis highlights the dominant and emerging topics related to the application of artificial intelligence (AI) in education. The term "Artificial Intelligence" appears with the highest frequency (6 articles) in the Author keywords category and relatively high (2 articles) in the Keywords-Plus category, confirming the central interest of the scientific community. At the same time, the topic of teaching is also important (5 articles), highlighting the relationship between artificial intelligence and educational practices. In addition, more specialized terms such as "AI Curriculum Design", "Autoethnography" and "Prompt Design" indicate a growing interest in the development of customized curricula and new methodologies for the use of artificial intelligence.

**Table 3:** Most Relevant Keywords.

| Author Keywords | Articles | Keywords-Plus | Articles |
|---|---|---|---|
| Artificial Intelligence | 6 | Teaching | 5 |
| Chat GPT | 2 | Economic and Social Effects | 5 |
| Social Influence | 2 | Curricula | 3 |
| AI Curriculum Design | 1 | Artificial Intelligence | 2 |
| AI in Education | 1 | Students | 2 |
| Autoethnography | 1 | Language Model | 2 |
| Genai | 1 | Social Influence | 2 |
| Generative AI | 1 | Article | 1 |
| Prompt Design | 1 | Carbon Dioxide Emission | 1 |
| Promptology | 1 | Conservation of Energy Resources | 1 |

There is considerable interest in the socio-economic impacts of AI, as indicated by the presence of terms such as "Social Influence", "Economic and Social Effects" and "Language Model". However, research gaps are observed, particularly on issues related to algorithmic transparency and environmental impacts, as indicated by the single mentions of terms such as "Carbon Dioxide Emission" and "Conservation of Energy Resource". This analysis reveals not only current research priorities but also opportunities for future research, particularly on issues of ethics, long-term evaluation of AI systems in education and their use in advanced economic simulations.

The analysis of keyword co-occurrence revealed significant research trends and key thematic axes that characterize the literature. The results highlight the frequency and relationships between critical terms, offering a global picture of the prevailing research directions. This study not only confirms the already established fields of interest, but also indicates potential gaps and opportunities for future research, thus enhancing the systematic understanding of the cognitive subject under consideration.

## Co-citation & Bibliographic Coupling

The methods of co-citation and bibliographic coupling are essential tools in bibliometric analysis, as they help to explore scientific relationships and map research fields. Through these techniques, researchers can identify thematic connections among publications, analyze scientific trends and identify gaps in the


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literature. Co-citation refers to the number of times two works are cited together in later studies, thus indicating their thematic affinity. While on the contrary, bibliographic coupling is based on the number of common references between two publications, revealing the connection of their research bases. However, both approaches contribute to understanding the development of scientific knowledge and the interaction between different research communities.

Figure 9 depicts the co-citation network of the authors of our study and the relationships between them, according to how often the authors are cited simultaneously in scientific publications. In addition, the nodes that make up the names of the authors are observed to have a different color, representing distinct groups. In some cases, there are also groups of authors who are often cited together. As for the lines between the nodes, these indicate the connection between the authors. The clusters, on the other hand, group the authors, indicating either collaboration or thematic similarity in their research.

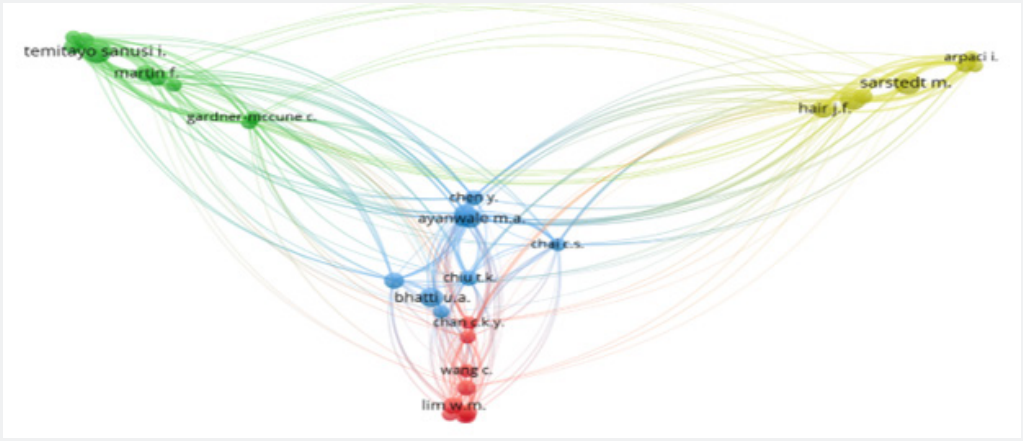


**Figure 9:** Co-citation authors.

Figure 10 shows the bibliographic coupling of authors, as it emerged from our study, using the VOSviewer program. This method is used to measure the similarity between two or more articles, according to the citations they share. The strength of the coupling depends largely on the number of common citations, i.e. the more common citations there are, the stronger the connection between the authors. This image helps us identify authors who study similar topics and who may not collaborate directly. Furthermore, through the analysis of these groups, emerging scientific fields can be identified.

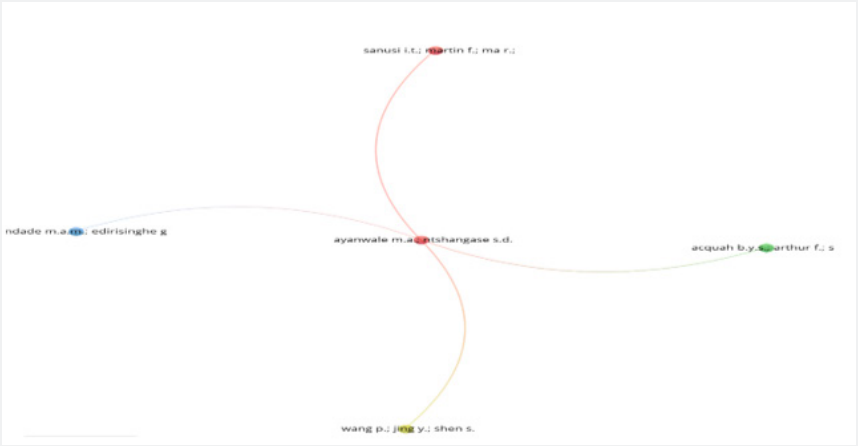


**Figure 10:** Bibliographic coupling authors.

Figure 11 below shows the bibliometric coupling of countries. This is a widely used bibliometric technique for analyzing research connections between different nations, based on shared citations in their academic publications. The focus is on the United Kingdom, which is interconnected with the United States and Finland, but also with South Africa, Nigeria, China and Ghana. When two or more countries cite the same references in their research articles, they are considered bibliographically connected. The strength of a coupling depends on the number of shared citations. This picture reveals countries that share common research interests, even if


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the researchers do not collaborate directly with each other. Furthermore, their strong coupling may indicate the creation of new academic collaborations or even changes in the focus of research.

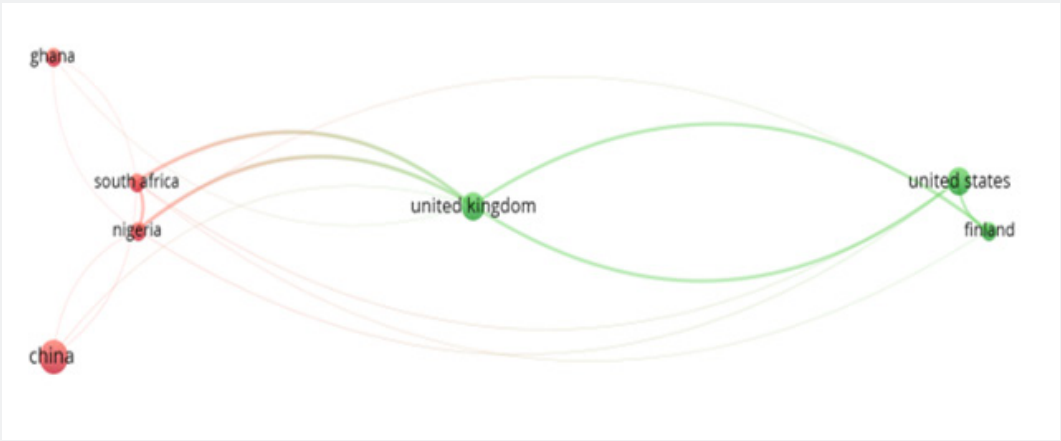


**Figure 11:** Bibliographic coupling authors.

In conclusion, co-citation and bibliographic coupling techniques offer essential information on the structure and dynamics of scientific production. Co-citation captures thematic relevance through shared references from third-party sources, while bibliographic coupling identifies relationships between studies based on their shared sources.

The utilization of these methods allows the identification of dominant research streams, the mapping of scientific fields and the prediction of future directions. In a constantly evolving scientific world, the application of these techniques is essential for the understanding and organization of scientific knowledge.

## Analysis of the Most Cited Articles

Table 4 provides a list of the top twenty most cited publications in the field of artificial intelligence and economics education. These papers represent key contributions that have shaped the discourse around the integration of artificial intelligence into teaching economics, reflecting the studies that have had the most significant impact on the field.

**Table 4:** Top 20 highly cited publications.

| No | Articles | Citations |
|---|---|---|
| 1 | Mehmood R, Alam F, Albogami NN, Katib I, Albeshri A, et al. (2017) UTiLearn: A Personalised Ubiquitous Teaching and Learning System for Smart Societies. IEEE Access 5: 2615-2635. [39] | 122 |
| 2 | Li C, Zhou H (2018) Enhancing the efficiency of massive online learning by integrating intelligent analysis into MOOCs with an Application to Education of Sustainability. Sustainability (Switzerland) 10(2). [40] | 76 |
| 3 | Cruz-Jesus F, Castelli M, Oliveira T, Mendes R, Nunes C, et al. (2020) Using artificial intelligence methods to assess academic achievement in public high schools of a European Union country. Heliyon 6(6): e04081. [59] | 67 |
| 4 | Coronado E, Mastrogiovanni F, Indurkhya B, Venture G (2020) Visual Programming Environments for End-User Development of intelligent and social robots, a systematic review. Journal of Computer Languages, 58: 100970. [69] | 64 |
| 5 | Metzler R, Kinzel W, Kanter I (2000) Interacting neural networks. Physical Review E - Statistical Physics, Plasmas, Fluids, and Related Interdisciplinary Topics 62(2 B): 2555-2565. [75] | 64 |
| 6 | Lin P-H, Wooders A, Wang JT-Y, Yuan WM (2018) Artificial Intelligence, the Missing Piece of Online Education? IEEE Engineering Management Review 46(3): 25-28. [73] | 63 |
| 7 | Russell RG, Novak LL, Patel M, Garvey KV, Craig KJT, et al. (2023) Competencies for the Use of Artificial Intelligence-Based Tools by Health Care Professionals. Academic Medicine 98(3): 348-356. [76] | 60 |
| 8 | Vermeulen KM, Doormaal VJE, Zaal RJ, Mol PGM, Lenderink AW, et al. (2014) Cost-effectiveness of an electronic medication ordering system (CPOE/CDSS) in hospitalized patients. Int J Med Inform 83(8): 572-580. [78] | 51 |
| 9 | Khosravi A, Malekan M, Pabon JJG, Zhao X, Assad MEH (2020) Design parameter modelling of solar power tower system using adaptive neuro-fuzzy inference system optimized with a combination of genetic algorithm and teaching learning-based optimization algorithm. Journal of Cleaner Production 244: 118904. [72] | 47 |


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| | | |
|---|---|---|
| 10 | Dai DD (2021) Artificial Intelligence Technology Assisted Music Teaching Design. Scientific Programming. [42] | 42 |
| 11 | Dehouche N, Dehouche K (2023) What's in a text-to-image prompt? The potential of stable diffusion in visual arts education. Heliyon 9(6): e16757. [71] | 37 |
| 12 | Friedrich S, Antes G, Behr S, Binder H, Brannath W, et al. (2022) Is there a role for statistics in artificial intelligence? Advances in Data Analysis and Classification 16(4): 823-846. [44] | 35 |
| 13 | Babkin AV, Burkaltseva DD, Betskov AV, Kilyaskhanov HS, Tyulin AS et al. (2018) Automation digitalization blockchain: Trends and implementation problems. International Journal of Engineering and Technology (UAE), 7(3.14 Special Issue (4): 254-260. [68] | 34 |
| 14 | Leoste J, Jõgi L, Õun T, Pastor L, López AMJ, et al. (2021) Perceptions about the future of integrating emerging technologies into higher education-The case of robotics with artificial intelligence. Computers 10(9). [43] | 33 |
| 15 | Crookes JG, Balmer DW, Chew ST, Paul RJ (1986) A three-phase simulation system written in pascal. Journal of the Operational Research Society 37(6): 603–618. [70] | 32 |
| 16 | Almaraz-López C, Almaraz-Menéndez F, López-Esteban C (2023) Comparative Study of the Attitudes and Perceptions of University Students in Business Administration and Management and in Education toward Artificial Intelligence. Education Sciences 13(6): 609. [45] | 30 |
| 17 | Thanh VH, Zamanyad A, Safaei-Farouji M, Ashraf U, Hemeng Z (2022) Application of hybrid artificial intelligent models to predict deliverability of underground natural gas storage sites. Renewable Energy 200: 169-184. [79] | 29 |
| 18 | Guerrero-Roldán AE, Rodríguez-González ME, Bañeres D, Elasri-Ejjaberi A, Cortadas P (2021) Experiences in the use of an adaptive intelligent system to enhance online learners' performance: A case study in Economics and Business courses. International Journal of Educational Technology in Higher Education: 18(1). [41] | 28 |
| 19 | Liu T, Wilczyńska D, Lipowski M, Zhao Z (2021) Optimization of a sports activity development model using artificial intelligence under new curriculum reform. Int J Environ Res Public Health 18(17): 9049. [74] | 24 |
| 20 | Samet RH (2011) Exploring the future with complexity science: The emerging models. Futures 43(8): 831-839. [77] | 21 |

The highly cited publications include foundational articles that introduced key artificial intelligence methodologies in economics education, such as personalized learning systems, artificial intelligence-driven simulations, or the application of machine learning in data analysis. Their prominence in citation counts suggests that these works have been widely recognized by scholars and have contributed to advancing research in the intersection of artificial intelligence and economics pedagogy. Analyzing these top papers provide insights into the major research themes, methodologies, and outcomes that have influenced the development of artificial intelligence - powered educational tools for economics.

The analysis of the 20 most frequently cited articles reveals important research trends and gaps in the field of artificial intelligence. Especially in educational applications and emerging technologies. One of the key themes that emerges is the personalization of learning through intelligent systems. Mehmood et al. [39] presents UtiLearn, a personalized teaching system that adapts to the needs of the learner, thus producing personalized learning in "smart societies" [39]. Similarly, Li & Zhou [40] emphasize the importance of integrating intelligent analytics into MOOCs to improve efficiency in massive online learning [40].

In addition, another critical issue is the application of Artificial Intelligence in the development of intelligent and adaptive learning systems. Guerrero-Roldán et al. [41] explore the use of an adaptive intelligent system to improve student performance in online Economics and Business courses, demonstrating that personalizing the educational experience can lead to better learning outcomes [41]. In parallel, Dai [42] examines the use of AI in music instructional design, offering an example of how AI can enhance creativity and interaction in the educational process [42]. However, these articles do not sufficiently analyze how transparency and impartiality can be ensured in algorithmic education systems.

As technological progress continues, several research gaps remain unexplored. Although some studies, such as Leoste et al. [43], examine perceptions of the integration of emerging technologies in higher education, they do not fully explore how these technologies affect teaching methodology and teacher-student interaction [43]. On the other hand, Li & Zhou (2018), although they explore large-scale applications, do not provide sufficient information on the generalizability and scalability of their models to different socio-economic contexts [40].

Furthermore, the integration of artificial intelligence into the educational process requires the development of new skills by the entire educational community. Friedrich et al. [44] discuss the role of statistics in artificial intelligence, highlighting the need for a greater understanding of algorithmic processes by educators so that they can properly utilize the capabilities of artificial intelligence [44]. At the same time, the research of Almaraz-López et al. (2023) records the attitudes of learners towards artificial intelligence, highlighting both the possibilities and the challenges related to the didactics of integration in university studies [45].

## Discussion

Artificial intelligence in economics education is playing an exciting role in teaching and learning practices. This is evident from


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the comprehensive bibliometric and keyword analysis conducted in this study. Our findings highlight the significant potential of AI technologies to enhance the learning experience. In addition, they highlight several important challenges and considerations for the future.

The increasing trend in the number of publications in this area since 2015 reflects a broader global shift towards adopting technology in learning environments. This increase can be attributed to the growing recognition of the potential of AI in improving both education and learning [46].

The analysis of 131 articles highlighted three main thematic areas that attract the most research activity:

I. Personalized learning: Much of the literature focuses on the development of adaptive learning algorithms that tailor the learning experience to the needs of learners, improving the understanding of complex economic concepts, such as macroeconomics and game theory [47].

II. Automated assessment: Studies highlight the use of AI for rapid grading and providing immediate feedback, reducing the required assessment time and offering more opportunities for diagnostic analysis of learning progress [48].

III. Bibliometric analysis: A significant proportion of articles use AI techniques to map scientific knowledge, allowing the identification of the most important publications and the detection of emerging research areas.

The data presented show that China and Spain are the main countries contributing to this research. This fact also signals the global interest, as well as the various investments that can be made for educational purposes in this sector. This global interest is not surprising, since in addition to artificial intelligence and machine learning, it has gained traction in various sectors, such as education [49-50].

Countries like the United States, the United Kingdom, and Russia also feature prominently in the research landscape, emphasizing that artificial intelligence's role in economics education is not limited to any one region. However, there is still noticeable underrepresentation of certain countries, especially in parts of the Global South. This geographical disparity raises important questions regarding the equitable access to artificial intelligence technologies and the potential digital divide, which could inhibit certain regions from fully benefiting from artificial intelligence - based educational tools [51].

The keyword analysis, especially the network and density visualizations, provides valuable insights into the evolving nature of artificial intelligence in economics education. Central keywords like artificial intelligence, teaching, and economics highlight that the application of artificial intelligence is fundamentally aimed at enhancing teaching methodologies, making economic education more engaging, personalized, and efficient.

Emerging keywords such as ChatGPT, smart systems in education, and economic and social effects suggest that there is an increasing focus on not just the mechanics of artificial intelligence - driven teaching tools, but also their broader implications. The rise of ChatGPT in particular points to a growing interest in artificial intelligence - powered conversational agents as essential tools for personalized learning. These technologies enable real-time interactions with students, offering tailored feedback, answering questions, and guiding learners through complex economic concepts [52]. This trend is crucial as it reflects a move towards more interactive and student-centered learning environments.

Additionally, the inclusion of economic and social effects as a prevalent keyword indicates that artificial intelligence 's role in education is increasingly being viewed through a broader socio-economic lens. The potential to not only enhance academic performance but also to foster critical thinking about the economic implications of artificial intelligence itself, is a promising area for future research. Moreover, the keyword energy conservation may hint at growing awareness of the environmental impact of digital tools in education, an area that warrants further exploration [53].

Another important area in which artificial intelligence, through advanced technical simulations, enhances education is finance. Traditional methods, such as Monte Carlo simulations, often require significant computing power and can be difficult for learners to interpret due to their complexity. However, artificial intelligence can optimize these simulations. It achieves this by enabling a more accurate representation of probabilistic paths and simplifying complex market models, such as focusing on critical areas [9]. Such areas can be risk measures, asset price bubbles [8] and structural estimation methods [7]. By integrating digital simulations into education, a more interactive and comprehensive learning experience can be provided, which reflects real financial decision-making processes.

Furthermore, the systematic literature review that was carried out highlighted that intelligent systems have the potential to transform the teaching of economics, enhancing both personalized learning and improving the teaching experience. The research demonstrates that adaptive educational technologies, combined with intelligent guidance systems, can support students in understanding complex economic concepts, adapting the content to their individual needs. At the same time, this type of technology allows the creation of simulations of economic phenomena, which improve the applied knowledge of learners in real-world scenarios.

Perhaps this is the most important benefit of artificial intelligence for the teaching of economics. That is, personalized learning. Technologies such as intelligent educational systems, learning analytics and adaptive content delivery are valuable tools for educators. Such tools allow them to tailor learning experiences to the needs, learning styles, and paces of individual students. Real-time


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analysis of student performance through artificial intelligence can identify gaps in knowledge or suggest personalized resources.

This is particularly important in economics, a subject that often requires a deep understanding of abstract theories, complex models, and quantitative analysis. Traditional pedagogical methods can struggle to cater to the diverse needs of students, whereas artificial intelligence-driven platforms can provide immediate feedback and guide students through interactive exercises and simulations.

However, the adoption of technical intelligence in education also poses several challenges. Examples of such challenges include the need to train teachers and the development of new pedagogical strategies. On the one hand, artificial intelligence tools are able to greatly improve the learning experience. On the other hand, however, teachers should also have the appropriate skills and practices in terms of teaching. Furthermore, there is a risk of excessive dependence on technology, which results in reduced critical human thinking. The human factor remains vital for promoting ethical reasoning, creativity and deep conceptual understanding [54].

Although artificial intelligence is a promising technology that is expected to revolutionize economics education, it raises several ethical and practical concerns. One of the most important issues is the possibility of algorithmic bias. In the context of education, and particularly in the field of economics, this could manifest itself in various artificial intelligence tools that provide inaccurate feedback or reinforce existing inequalities or fail to provide equal learning opportunities for learners [55]. Our research analysis shows that problems with "hallucinations" still exist, which highlights the need for critical evaluation of results by researchers and educators.

Data security and privacy are two other challenges of artificial intelligence. Regarding the education sector, there are several cases where access to a large volume of student data is deemed necessary. For this reason, ensuring the integrity of the data is considered of utmost importance. Regarding educational institutions, the latter should be transparent and secure in terms of the collection, processing and storage of student data. In addition, they should operate within the framework of the applicable legislation for the protection of personal data, in line with the standards of the General Data Protection Regulation (GDPR) in Europe [56]. Potentially, future studies could explore how these policies differ across countries and how they can be effectively implemented in different education systems.

In addition, one of the most critical issues that needs to be addressed is the digital divide [57]. Although educational digital tools have the potential to improve learning outcomes, many students in areas with limited internet access may not be able to keep up with this type of technology. This inequality in access could exacerbate existing educational inequalities. Especially in developing countries or in underfunded schools.

The results reveal not only clear trends in the literature, highlighting both areas of intense research activity, but also areas that remain underexplored. Personalized learning through artificial intelligence emerges as the most focused area of research, as a significant proportion of the articles examine the use of adaptive learning algorithms to improve the teaching of complex economic concepts [39][58]. The results of these studies show that the implementation of personalized systems provides improved learning outcomes and supports differentiated teaching, especially in demanding quantitative fields, such as macroeconomics, microeconomics and game theory. These approaches offer learners personalized learning paths, enhancing the understanding of abstract concepts and the possibility of practical application in real-world scenarios. An equally important area of research concerns the use of artificial intelligence for automated assessment and feedback. Most studies highlight the advantages of automated assessment in reducing the time required for grading and providing immediate feedback to learners [26]. However, concerns are raised about the reliability and transparency of these algorithms, especially when assessing qualitative responses or complex economic problems [55].

Bibliometric analysis is also an important research area, with researchers leveraging artificial intelligence tools to analyze large scientific data sets and map research trends [59]. These studies facilitate the identification of the most important publications and emerging thematic areas at the intersection of artificial intelligence and economic education. However, despite the usefulness of these tools, there is limited focus on the challenges related to the reliability of the results produced by Large Language Models (LLMs), which often exhibit "hallucinations" or misreporting [20].

Our literature review has highlighted several areas of research that present opportunities for future research. Perhaps the most prominent are the ethical and legal issues surrounding the use of artificial intelligence in economic education. Although these issues are considered important, only a small proportion of the articles explore the ethical challenges that arise from the use of artificial intelligence in the educational process [8]. Several other important issues, such as data privacy, the impartiality of algorithms, and the intellectual property of automatically generated learning materials, remain largely unexplored.

Another important research gap concerns the applications of artificial intelligence in financial simulations, as a very small percentage of articles refer to the use of artificial intelligence for teaching complex financial methods, such as Monte Carlo simulations and structural estimation [7][9]. Despite the fact that these techniques are crucial for modeling financial risks and understanding market dynamics, their integration into teaching with the help of artificial intelligence remains limited.

Despite significant progress in some areas, the analysis revealed that some research areas are understudied or underrepresented in the literature:


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Areas with increased research activity:

- Personalized learning: The majority of studies focus on leveraging intelligent systems to create differentiated learning paths, aiming to improve understanding of complex economic phenomena.

- Automated assessment: A satisfactory number of articles examine the use of artificial intelligence to analyze assessment data, provide immediate feedback, and reduce bias in grading.

Areas with incomplete study:

- Empirical evaluation of artificial intelligence tools: Despite the growing number of studies, long-term empirical research evaluating the lasting impact of artificial intelligence on learner performance is lacking.

- Ethical and legal issues: Only a small percentage of articles address issues such as algorithmic bias, data privacy, and transparency in the use of AI in education [60].

- Applications of AI in financial simulations: Although simulations such as Monte Carlo are critical in teaching financial models, few articles focus on this area [61].

This study contributes to the literature by providing a comprehensive overview not only of the use of artificial intelligence in teaching economics, but also by highlighting the main areas of focus and knowledge gaps. Second, it maps the relationship between AI and teaching practices, allowing researchers to identify neglected areas for further investigation. Third, it highlights the need for interdisciplinary collaboration between AI experts, economists, and educators to develop more comprehensive and ethically responsible teaching models.

In conclusion, artificial intelligence can transform economic education by providing personalized learning experiences. At the same time, it can enhance student engagement and improve teaching effectiveness. In order to fully integrate artificial intelligence into economic programs, a number of ethical dilemmas and practices need to be addressed, which are analyzed in this study. As the research landscape evolves daily, it will be essential for educators, researchers, and policymakers to collaborate to ensure the best use of artificial intelligence. A use that benefits all students and educators.

## Limitations and Further Research

While our bibliometric analysis provides a comprehensive overview of the contribution and utilization of artificial intelligence in economics teaching, some limitations should be noted. First, our study relied on data from a central database, Scopus, which, although widely regarded for its extensive coverage, may exclude relevant studies indexed in other databases or non-English publications [62]. This choice could limit the generalizability of our findings across regions or languages. Future research could benefit from including additional databases, such as Web of Science (WoS), ScienceDirect, or IEEE Xplore, to capture a broader range of studies and enhance representativeness.

Table 4 lists the 20 most cited articles. However, one might notice that these articles seem to be particularly related to broad applications of artificial intelligence in educational settings, and not to economic education per se. However, this does not mean that artificial intelligence cannot be applied to the learning of economic sciences. But one might wonder to what extent economics lags behind other disciplines in terms of the use and exploitation of artificial intelligence for educational purposes. Although artificial intelligence can be applied in educational settings, its use in economics may lag behind other educational disciplines. This is due either to the complexity or the particular characteristics of economic science. Data in the economic field are characterized by their difficulty in capturing and their high uncertainty. Furthermore, traditional economics education focuses on developing critical thinking and theoretical knowledge. This is why the adoption of artificial intelligence, especially in an academic environment, is difficult. Finally, economics education is also connected to other sciences, requiring an interdisciplinary approach. As technology evolves, it is likely that artificial intelligence will play a more active role in economics education.

Future research should also explore the application of AI to finance education, particularly in terms of enhancing the accessibility and interpretability of advanced simulation techniques. Although this study focuses specifically on economic education, there is a growing need to evaluate how AI-based methods, such as Monte Carlo simulations and structural estimation, can facilitate the teaching of complex financial educational models. Further studies could perhaps examine the pedagogical effectiveness of these tools in improving learners' understanding of market dynamics and the assessment of potential economic demands of a state.

In addition, our analysis focused on citation counts, co-author networks, and keyword co-occurrence to identify key topics, researchers, and collaborations. These bibliometric methods provide valuable information, but may not fully capture the qualitative aspects of artificial intelligence or the practical impact on the transmission of economic knowledge. Future research could incorporate a qualitative review of selected articles to deepen understanding of the implications and applications of specific innovations in economics teaching.

For the future, it is proposed to focus on the following key areas of research, which are related to the investigation of ethical and legal issues, as well as the assessment of educational effectiveness. Further research is necessary to understand the consequences of the use of artificial intelligence in economic education, with an emphasis on the transparency of algorithms and the protection of personal data. Furthermore, empirical studies are needed to evaluate the long-term impact of artificial intelligence on the critical thinking and problem-solving skills of economic learners.

Finally, our study does not examine potential cultural, regulatory, or organizational factors that influence the adoption of


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artificial intelligence technologies in economics courses across countries. Future studies could explore these relevant factors, providing insights into how different regions approach artificial intelligence and how they leverage it to embed and transmit economics knowledge or lessons.

## Conclusion

Integrating artificial intelligence into teaching is a promising development, providing the opportunity to reshape traditional educational methodologies and improve not only teaching effectiveness, but also student learning outcomes [63]. Taking advantage of personalized learning paths, real-time data analysis, and interaction offered by this type of technology, more engaging, flexible, and effective educational experiences are created [64]. These innovations provide students with an understanding of complex economic concepts, as well as allowing them to receive immediate feedback tailored to their individual needs.

However, the integration of digital technology, and specifically artificial intelligence, in economics teaching methods cannot be without challenges. Some of the issues that arise are data privacy, unequal access to technology, algorithmic bias and the need for comprehensive teacher training [65]. Successfully addressing the previous issues will ensure the fair and ethical distribution of the benefits arising from the use of artificial intelligence. Furthermore, teachers should be particularly careful about their dependence on this technology and in no case should it replace them, especially with regard to critical thinking, human judgment and the socio-cultural context, which are vital for economics as a field of study.

In the future, artificial intelligence in economic education can be expanded even further, offering not only more sophisticated teaching tools, but also improved learning and review practices. In a constantly evolving technological environment, there will also be opportunities to evolve personalized learning experiences that can adequately prepare learners. By addressing any challenges and utilizing all the capabilities and functions of artificial intelligence, educators will be able to further promote the understanding of economic and equip students with the necessary skills.

The bibliometric analysis carried out reveals the dominant research trends, geographical distributions and key research gaps in the application of artificial intelligence in economics education.

Regarding the first research question, the main trends and research areas of the use of artificial intelligence in economics teaching, our analysis revealed that research focuses mainly on the thematic axes of personalized learning, automated assessment and bibliometric analysis. Artificial intelligence is widely used to create personalized learning experiences, such as adaptive teaching systems [66]. Studies show a positive impact on student performance, especially in courses with a strong quantitative nature, such as macroeconomics and finance [58]. Artificial intelligence is used to grade assignments, analyze answers and provide feedback [55]. Despite significant progress, there are also challenges in terms of transparency and algorithmic bias. The studies use artificial intelligence to map scientific trends and analyze references in the literature. This helps to identify key research pillars and collaborations [59].

Furthermore, regarding the second research question on what are the geographical and thematic distributions in research on artificial intelligence in economic education, the bibliometric analysis highlighted the geographical distribution of the studies. The United States of America is pioneering studies on adaptive learning and machine learning in education, China emphasizes autonomous assessment systems and big data analysis in the educational process, while Europe focuses on interdisciplinary research that combines artificial intelligence with educational policies and ethics. According to VOSviewer, the most frequent terms appearing in the publications are: artificial intelligence, chat gpt, economic and social influence, language model. This indicates that research is mainly focused on technological and educational applications of AI.

Regarding the third research question on existing research gaps and possible directions for future research, the analysis revealed the absence of empirical studies, the existence of ethical and legal issues, and applications of AI in financial simulations. Most studies are theoretical or based on small-scale experimental data. Therefore, more extensive empirical studies are needed to evaluate the effectiveness of AI in real classrooms [39]. Furthermore, there is a lack of research on the transparency of AI algorithms, the privacy of learner data, and the ethics of using educational algorithms [20]. Only a small percentage of studies focus on the use of AI for Monte Carlo simulations, structural estimation, and other economic models [8]. This is an untapped research field that could provide new insights into the teaching of economics and finance.

Future research should therefore focus on empirical studies, ethical issues, and financial simulations, in order to maximize the academic and practical contribution of artificial intelligence to the educational system [67].

This study offers a substantial contribution to the scientific community, focusing on the investigation of the application of Artificial Intelligence (AI) in the teaching of economics. Through bibliometric analysis, this work maps the research landscape, identifies gaps in the literature and suggests new directions for future research.

One of the main axes of the study's contribution is the comprehensive bibliometric overview it provides [68-72]. This study collects, analyzes and categorizes the relevant scientific production, offering a structured and systematic presentation of the dominant themes emerging from the use of AI in economics education. Through this analysis, three main research directions emerge: adaptive learning, automated assessment and bibliometric analysis. This mapping provides researchers and education


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professionals with an overall picture of the research progress and applications of AI in the educational process.

Furthermore, the study contributes to highlighting important research gaps that require further investigation. In particular, it identifies three main areas where research remains insufficient or limited:

1. Empirical validation: Despite increasing theoretical and technological progress, there is a lack of long-term empirical studies evaluating the effectiveness of AI systems in economic education over time. Conducting such studies is essential to clarify the real impact of AI on the learning experience and educational outcomes.

2. Ethical and legal issues: Another important gap concerns the ethical dimension of the use of AI in education. Issues such as algorithmic fairness, data privacy, and algorithmic transparency remain under-examined, despite their significant importance in ensuring a fair and ethically responsible educational practice.

3. Financial simulations: While AI has proven its usefulness in basic teaching practices, its integration into advanced financial simulations, such as Monte Carlo simulations and structural estimations, remains limited. Exploring the contribution of AI in these areas could improve the teaching approach to complex financial analyses.

This paper is not limited to only mapping the current situation, but also suggests specific directions for future research. More specifically, three main areas for further study are suggested:

1. Investigating the long-term impact of AI systems on teaching practice: Future research should focus on developing longitudinal studies that evaluate the impact of AI tools on student learning performance and educational experience [72-75].

2. Developing research on ethical issues: Further exploration of ethical and regulatory issues is needed, particularly with regard to the use of personal data, algorithmic transparency and the protection of students' rights.

3. Using AI in advanced economic simulations: There is a need for studies that will examine the potential of AI to improve the teaching of complex economic models, such as financial risk simulation and dynamic market simulations.

In summary, this study offers a multidimensional contribution to the literature, providing both a systematic mapping of existing knowledge and clear proposals for future research developments [76-79]. The application of AI in economic education is in a developmental stage, with much potential for further innovation, particularly in the areas of empirical validation, ethical governance and economic modeling.

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