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AI Applications in Engineering and Scientific Reasoning: A Systematic Literature Review

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Abstract: Artificial intelligence (AI) has become a very influential technology in various fields, including engineering and science. This study aims to conduct a systematic literature review that addresses gaps in various literatures to identify effective AI applications in engineering and scientific reasoning. The review was conducted on 42 articles from 4 reputable publisher databases, Scopus, ScienceDirect, Eric, Sage Journal in 2015-2025. The review process uses PRISMA, the visualization results use Datawrapper. *Artificial Intelligence* is increasingly popular in engineering and science due to its ability to improve efficiency and accuracy. The findings of this study contribute to a better understanding of the application of *Artificial Intelligence* (AI) in the fields of engineering and scientific reasoning. This study analyzes the content of the application of *Artificial Intelligence* (AI) and benefits in engineering and scientific reasoning based on year of publication, type of publication, country of research, content discussed. The findings of this systematic review indicate that AI has been used in system design, process control, data analysis, and predictive model development. The results of this synthetic review can be used to see the application of artificial intelligence in fields other than engineering and scientific reasoning according to needs and broader benefits in its application.

Keywords: Artificial intelligence, Engineering, Scientific reasoning, Systematic literature review, Data analysis datawrapper

Introduction

The benefits and applications of Artificial Intelligence (AI) have undergone extraordinary development and transformation into one of the drivers of technological innovation in various fields, in materials science and engineering (MSE), industrial applications, the use of algorithms, computational models, especially in engineering and science (Lipichanda, 2023; Butler, 2018; Liu, 2021). Artificial Intelligence has a wide range of scopes, namely systems and devices that can create similarities in human cognitive abilities such as learning, reasoning, and decision making thanks to techniques such as machine learning,

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deep learning, computer vision, and natural language processing (Janiesch, 201; Malloy, 2024; Shoenbill, 2023).

The rapid and growing development of Artificial Intelligence encourages the interest to review comprehensively and systematically how the benefits and applications of Artificial Intelligence in various countries. Several previous studies have discussed the review of the benefits of IA in various fields such as: review of the application of machine learning (ML) models to energy systems and the manufacturing industry (Mosavi et al., 2019).

Furthermore, the PRISMA review focuses on Explainable AI (XAI) in industrial prognostics and Health Management (PHM) on industrial assets, the application of XAI in manufacturing processes to support and improve operational decisions, IA for building energy management (Nor, 2021; Sofianidis et al, 2021). The effectiveness of implementing Artificial Intelligence in providing benefits in various fieldsstudy. However, there is still an opportunity to review systematic reviews specifically discussing Artificial Intelligence in the field of engineering and science (scope of scientific reasoning) in full with data visualization and depth.

Thus, this study aims to fill this opportunity through a systematic literature review (SLR) that examines 42 articles from an initial search of 6,670 articles over the past 10 years from 2015-2025. This systematic literature review contributes to help understand the integration of collaboration between researchers, the focus of research study analysis, the country of origin of researchers, and the scope of integration that is sought in this research process. To support the research review, the author asks several questions in the research as follows :

RQ 1. What are the research trends on the application of Artificial Intelligence in various countries when viewed based on years publication, author's country of origin, source of journal article publisher?

RQ2. What are the characteristics of the application of Artificial Intelligence in various fields that are developed in engineering context and scientific reasoning?

RQ3. How is the integration of Artificial Intelligence beneficial in engineering and scientific reasoning?

Based on *Request Question* above can be continued using analysis *systematic literature review.* The contribution to the review in this study fills the existing gap based on *Request Question* which has been set.

Method

This study uses the Systematic Literature Review method with PRISMA technique synthesis analysis. *Systematic Literature Review*is a method that is designed systematically and structured to identify, synthesize, and integrate findings from various studies that are relevant to a particular topic. One of the supporting parts of the data analysis technique used in the Systematic Literature Review is PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analysis*), a technique used to ensure that the process of searching, selecting, and synthesizing articles is carried out accurately, openly, and thoroughly in answering relevant research questions (Moher et al., 2021; Liberati et al, 2009; Brignardello, 2025).

The PRISMA technique provides structured guidelines for each step in the search and analysis process to ensure the quality and results of the research. The use of PRISMA aims to reduce bias in processing various literatures that are categorized according to research questions (RQ) and increase accuracy in analyzing literature]. This technique is widely used in research in various fields of science. (Page et al., 2021; Rethlefsen, 2021; Glotan, 2018; Cochrane, 2025)

The application of PRISMA aims to align with the research question and identify the main search terms startingwith the stage of identifying relevant articles from various predetermined sources. The first step is to search for articles using the right keywords related to the research topic, in this case regarding "Implementation of IA applications in engineering and science (scientific reasoning). In this study, the search was conducted through four reputable publication databases, namely Scopus, Science Direct, SAGE, ERIC. The systematic literature appraisal process (PRISMA) consists of three steps: Identification of journals to be included in the systematic review as follows:

Table 1. Request question database

Criterion	Inclusion	Exclusion
Publication Date	Last 10 years (2015 – 2025)	Others
Publication Type	Journal Article	Review, conference proceeding, and others
Language	English	Any language other than English
Publication stage	Final	Article in press
Accessibility	Full-text article atau open access	Review articles atau lainnya
Keywords	("Implmentation IA Application" OR IA Application in Enginering and Scientific Reasoning"	Others

Initial search on scopus database is 84, ScienceDirect 6,286, Sage journal 22, Eric 278, then total 6,670 overall resulting in article titles. Through this process, the articles are analyzed according to the research questions answered based on RQ 1-RQ 3 only 42 articles with the specification of IA application in scientific techniques and reasoning. From the many articles found were removed for several reasons: combined articles from publication types, ex:*book review, review article, procedure*g, too specific to other fields of study, not related to scientific techniques and reasoning and does not answer RQ1-RQ3. In this research stage, three stages were carried out, namely, *Screening* (Filtering), filtering or selecting data : *Eligibility* (Feasibility), determining articles that will be used as material for literature assessment; And*Inclusion* (Inclusion), combining and reporting results (Okoli, 2010; Siddaway, 2019; Liberati et al., 2009; Moher et al., 2009; Page et al, 2021).

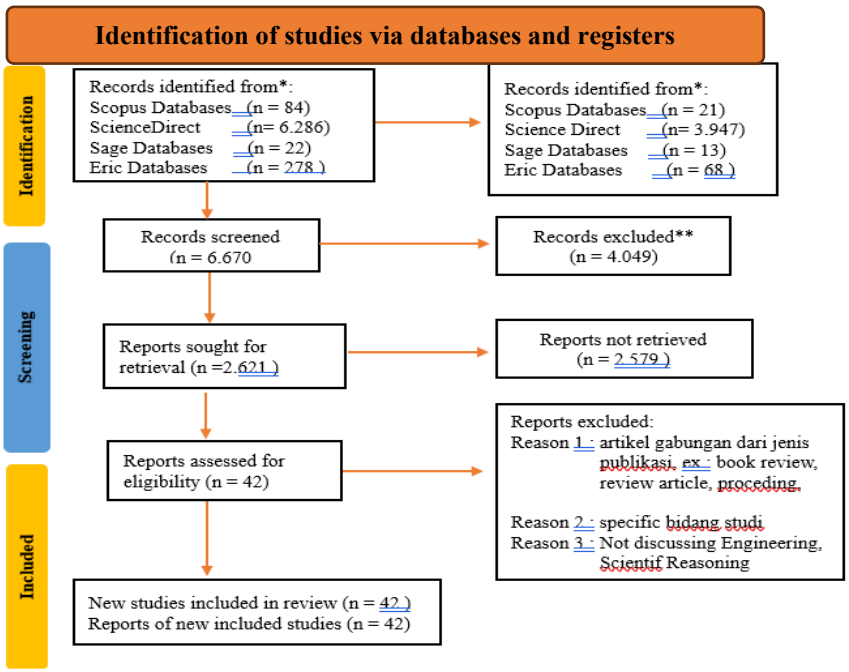

Figure 1. PRISMA diagram

Specific time frame, such as 2015-2025. This process ensures that only relevant and high-quality studies will be analyzed. Once relevant articles have been screened, the next step is data extraction, where key information from articles that meet the criteria will be collected and synthesized. Data extraction involves identifying key findings from each article, including the methodology used, research results, and recommendations for further research.

This process will provide a comprehensive overview of the development of the conceptual change model in physics learning. The results of this analysis are then systematically arranged, both in narrative and tabular form, to compare the findings from the various articles that have been analyzed. Finally, the last stage in PRISMA is to compile a report that summarizes all the findings obtained and provides suggestions based on existing evidence for further research (Okoli, 2010; Siddaway, 2019; Liberati et al., 2009; Moher et al, 2009; Page et al., 2021)

PRISMA as a technique in *Systematic Literature Review* provides significant advantages in seeing the development and benefits of artificial intelligence in every field. By applying PRISMA, researchers can identify and combine findings from various studies that focus on engineering and science, namely scientific reasoning. Several studies using the PRISMA method have succeeded in summarizing findings from various articles that show the effectiveness of applying the benefits of artificial intelligence in various fields.

Data Analysis

The PRISMA stages followed in this study include several main steps. The first step is a search for relevant literature based on predetermined keywords, namely "implementation IA application" OR IA Application in Engineering and Scientific Reasoning". Furthermore, the articles found were filtered based on inclusion and exclusion criteria, such as year of publication (2015-2025), type of article (only journals*peer reviewed*), and focus on scientific techniques and reasoning. The selection process is carried out by considering the quality of the methodology and its contribution to the development of conceptual change in physics education. After selection, articles that meet the criteria are then analyzed to identify key findings and novel recommendations.

The distribution of research in the articles analyzed shows that most studies focus on secondary and tertiary education levels, with the main topic regarding the application of IA Application in Engineering and Scientific Reasoning. The data obtained then entered the tabulation stage in the form of tables and mapping classification according to the framework that has been set in*Request Question.*Based on the search results in a long and detailed selection process for the last five-year period, namely January 2015 to June 2025 in 4 reputable journal article publishing databases, namely: Scopus, Sage, Eric and Science Direct 42 journals from 6,670 research articles that appear with a search on the initial keywords.

Result and Discussion

Research Question (RQ 1)): How are the research trends on the application of artificial ıntelligence in various fields when viewed based on the year of publication, country of origin of the author, source of the journal article publisher?

This study was reviewed from 2015-2025 with initial results obtained 6,670 articles from 4 publisher databases and the results of a detailed and comprehensive in-depth selection obtained 42 journal articles that will be reviewed systematically. There are 15 countries over the past five years can be seen in full in the following table and figure:

Table 2. Percentage of most countries

No	Affliated Country	Article Writer	Article Frequency	Percentage(%)
1	United States	25	10	23.8 %
2	Indonesia	16	3	7.14 %
3	Canada	15	3	7.14 %
4	Swiss	14	3	7.14 %
5	Colombia	10	2	4.76 %
6	Brazil	8	2	4.76%
7	United Kingdom	7	2	4.76%
8	India	3	2	4.76%
9	Germany	6	2	4.76%
10	Hongkong	6	1	2.38%
11	South Africa	5	3	7.14 %
12	Iran	5	2	4.76 %
13	Thailand	4	1	2.38 %
14	Saudi Arabia	4	1	2.38 %
15	Finland	3	1	2.38 %
16	Philippines	3	2	4.76 %
17	Turkey	3	2	4.76 %
	Total	138	42	100 %

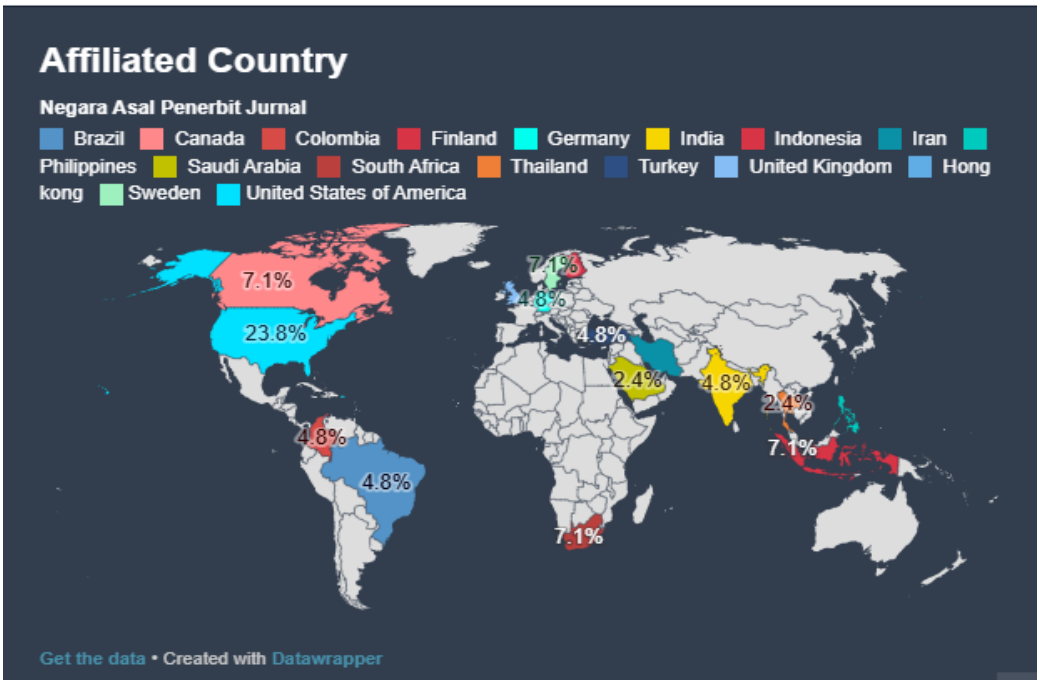

Figure 2. Map of countries affiliated country

Journal article publisher sources to answer *Request Question* the last one in the research question (RQ 1) can seen as follows:

Table 3. Decription of author and publisher of the article

No	Author	Year	Journal Name	Publisher
1	Abdul Gaffar Sheik et al.	2025	Engineering Applications of Artificial Intelligence	Science Direct
2	Paul Martin, Nicole	2024	Computers and Education: Artificial Intelligence	Science Direct
3	Jennifer Li et al.	2024	Computers and Education: Artificial Intelligence	Science Direct
4	Amogh Sirnoorkar et al.	2024	Computers and Education: Artificial Intelligence	Science Direct
5	Venkat Venturs	2022	Computers and Education: Artificial Intelligence	Science Direct
6	Julien Chapelin et al.	2025	Engineering Applications of Artificial Intelligence	Science Direct
7	Lindelani Mnguni et al.	2024	Computers and Education: Artificial Intelligence	Science Direct
8	Luiz Rodrigues	2024	Computers and Education: Artificial Intelligence	Science Direct
9	Ismalia et al.	2022	Computers and Education: Artificial Intelligence	Science Direct
10	Lindelani Mnguni et al.	2024	Computers and Education: Artificial Intelligence	Science Direct
11	Tanya Nazaretsky et al.	2025	Computers and Education: Artificial Intelligence	Science Direct
12	Federico, Perneilla, Anne	2025	Computers and Education: Artificial Intelligence	Science Direct
13	Ehsan Latif, Xiaming Zhai	2024	Computers and Education: Artificial Intelligence	Science Direct
14	Thomas, Chiu et al.	2024	Computers and Education: Artificial Intelligence	Science Direct
15	Nils Knoth	2024	Computers and Education: Artificial Intelligence	Science Direct
16	Antonio , Martina	2024	Computers and Education: Artificial	Science Direct

			Intelligence	
17	Karim, Robert	2024	International Review of Research in Open and Distributed Learning	ERIC
18	Catherine Fichten et al.	2022	The Journal on Technology and Persons with Disabilities	ERIC
19	Giray, Jacoob , Gurmalin	2024	International Journal of Technology in Education	ERIC
20	Muhammad Imran, Norah Al	2023	Contemporary Educational Technology	ERIC
21	Jose Ramon et al.	2023	Media Education Research Journal	ERIC
22	Gina Paola et al.	2024	Electronic Journal of e-Learning	ERIC
23	Megan Lowe	2024	Research Issues in Contemporary Education	ERIC
24	Beatrice Bonarni	2020	Media Education Research Journal	ERIC
25	Azza Abdullah AlGhamdi1	2022	International Journal of Higher Education	ERIC
26	Ferdiye	2023	The EuroCALL Review	ERIC
27	Ezema, Ugwuany Okeke	2022	Journal Of Turkish Science Education	ERIC
28	Yiwen Li	2024	Studies in Applied Linguistics	ERIC
29	Edwin et al.	2023	Journal of Social Studies Education Research	ERIC
30	Jose Ramon et al.	2023	Media Education Research Journal	ERIC
31	Michele Harris	2025	Impacting Education Journal	ERIC
32	Rebecca et al.	2024	Clinical Imaging journal	SCOPUS
33	Stephen et al.	2024	Clinical Imaging journal	SCOPUS
34	Jonas et al.	2021	Physica Medica	SCOPUS
35	Federico et al.	2025	Computers and Education: Artificial Intelligence	SCOPUS
36	Jamie et al.	2024	Value in Health	SCOPUS
37	Amin et al.	2024	Clinical Imaging journal	SCOPUS
38	Adam et al.	2024	Clinical Imaging journal	SCOPUS
39	Chetan et al.	2024	Applied Sciences	SCOPUS
40	Sabeena et al.	2020	Canadian Association of Radiologists Journal	SAGE JOURNAL
41	William et al.	2023	Canadian Association of Radiologists Journal	SAGE JOURNAL
42	Jaryd et al.	2020	Canadian Association of Radiologists Journal	SAGE JOURNAL

Research Questions (RQ2): What are the characteristics of the application of artificial ıntelligence in various fields developed in the context of engineering and scientific reasoning?

Recent studies have shown that the application of artificial intelligence (AI) has an important and transformative role in supporting and strengthening the scientific reasoning process, especially in the context of engineering and science education. Artificial intelligence (AI) capabilities in natural language processing (NLP) Decision making, complex system modeling, engineering process optimization, and processes to develop students' scientific thinking skills; Such as deductive, inductive, analytical and evaluative. Large-scale language models (LLM) such as ChatGPT are now beginning to be used as intellectual companions in various scientific activities. Its role includes assistance in designing science-based arguments, interpreting experimental results, to developing engineering solutions based on a scientific approach (Kasneci et al., 2023).

In engineering, AI technology has emerged as an essential tool not only in data-driven analysis and modeling of complex systems, but also as a medium that encourages deeper engagement in the scientific reasoning process. This technology supports learners and researchers to critically review their scientific processes, test hypotheses, assess the validity of data, and draw rational conclusions (Flores Limo et al, 2023). The use of AI in this scenario enables more active and in-depth cognitive interactions, strengthens inquiry-based learning approaches, and stimulates evidence-based scientific reasoning skills (Jacob et al, 2023).

Table 4 Distribution of research classifications by field and benefit

No	Field	Benefits of AI in Research
1	Health	Handling of lung cancer
2	Radiology	Evaluation framework in the field of radiology.
3	Radiology	The role and potential of AI in supporting emergency and trauma radiology departments.
4	Educational Technology	The ability of prompt engineering to integrate AI literacy into the curriculum.
5	Medical Physics	Offers a SWOT analysis as a strategic tool for healthcare institutions and universities.
6	Medical Diagnostics	Supports the development of MRI- and AI-based clinical decision support systems for neurology.
7	Breast Imaging (Radiology)	Assists radiologists in distinguishing between benign and malignant conditions based on morphology, distribution, and enhancement patterns
8	Educational Technology	Provides guidance and ethical supervision in AI use to avoid hindering independent evaluation..
9	Science Education	Integrates AI into teaching practices.
10	Industry	A data-driven framework for drift detection and diagnosis in real industrial environments
11	Science Education	Integrates AI into teaching practices
12	Biological Wastewater Treatment Technology	Enhances transparency, fairness, and trust in AI models for wastewater treatment plant management.
13	Language Education	The benefits of ChatGPT in second language acquisition.
14	English Language Teaching	The benefits and potential uses of ChatGPT in L2 (ESL) Writing instruction.
15	Technology in Scientific Research	Supports scientific research methodology and processes through SWOT-based analysis (Strengths, Weaknesses, Opportunities, Threats).

Although the development of AI use in engineering education is quite rapid, systematic studies that explicitly explain the role of AI in strengthening scientific reasoning are still relatively minimal, especially in the context of engineering learning in the modern era (Imran & Almusharaf. 2023; Bin-Hady et al, 2023). Therefore, this study focuses on conducting a systematic literature review (SLR) of recent research in the period 2015–2025. The results of the article review identify the main functions of AI in strengthening scientific reasoning in engineering learning (Kasneci et al., 2023).

Examining the types of scientific reasoning (such as deductive, inductive, evaluative, and predictive) developed through the use of AI technology (Fitria, 2021), Analyzing the implementation of AI in the context of engineering education and scientific experiments, including the use of LLM, decision support systems, and intelligent simulations (Haristiani et al., 2019), Examining the ethical, pedagogical, and cognitive challenges that arise along with the integration of AI in the development of critical and authentic scientific reasoning (Jacob et al., 2023; Bender et al., 2021). This review refers to articles obtained from four reputable scientific databases such as Scopus, ScienceDirect, ERIC, and SAGE Journal—with a selection focus on publications that directly link the use of AI to improving the quality of scientific reasoning in the context of engineering and science education.

RQ 3. How is the integration of artificial ıntelligence beneficial in the field of engineering and scientific reasoning?

Based on a synthesis of various scientific literature, it is known that artificial intelligence (AI) has been widely used in various fields of engineering and science education. AI has played a role in the development of automatic control systems, engineering process simulations, and complex experimental data analysis. In the educational environment, the application of AI includes supporting engineering learning activities through recommendation systems, data- driven simulations, and the use of large language models (LLM) in scientific discussions and reasoning (Kasneci et al., 2023; Flores Limo et al., 2023).

In the context of strengthening scientific reasoning, AI enables more dynamic cognitive interactions between learners and technology. Through LLMs such as ChatGPT, learners can develop skills in formulating arguments, proposing hypotheses, and drawing conclusions based on data and scientific logic (Dwivedi et al., 2023). This interaction is considered to encourage deeper reflection and critical thinking

on the engineering phenomena being studied. Several studies also emphasize the role of AI in assisting inquiry-based learning and project-based learning processes, which significantly improve the quality of students' evaluative and predictive reasoning in solving real-world engineering problems (Schbel et al., 2023). The use of AI-based systems in engineering learning can direct students to explore various engineering solutions systematically and based on data. However, the limited literature that explicitly links types of scientific reasoning such as deductive, inductive, evaluative, and predictive with the use of AI is still an important note. Many studies have not explained in detail the indicators of scientific reasoning developed through interaction with AI, so a more in-depth analysis is needed in further studies. In addition, most of the application of AI is still focused on higher education. Research targeting the secondary level, especially in complex topics such as momentum and impulse, rotational dynamics, and energy systems is still relatively small (Ibrahim & Kirkpatrick, 2023). This opens up opportunities for further research that examines the integration of AI in engineering learning at the secondary school level.

On the other hand, ethical and pedagogical issues related to the use of AI in learning are also of concern. Challenges such as the potential for plagiarism, dependence on AI, and decreased critical reasoning must be anticipated with appropriate learning strategies. Therefore, the use of AI in engineering education needs to be carefully designed to continue to facilitate authentic and in-depth evidence-based scientific reasoning (Jacob et al., 2023).

Conclusion

Artificial Intelligence (AI) now plays a significant role in the development of engineering and strengthening scientific reasoning. Based on a systematic review of 42 publications from a number of internationally reputable databases, it was found that AI is widely applied in system design, data processing, and the preparation of intelligent algorithm based prediction models. In addition to its contribution to technical aspects, AI has also been proven to help improve data-based scientific thinking skills. However, the use of AI still faces obstacles, such as limited user understanding and ethical issues. The results of this study indicate that AI has great potential to support educational innovation and engineering research on an ongoing basis.

The results of synthesis and*review*This can provide evidence that *Conceptual Change Model* can serve as a learning model that reduces misconceptions and corrects erroneous scientific concepts. In doing so, we also identify gaps in this knowledge base and we offer a series of concrete recommendations for future research along with specific research questions. We hope that this paper will provide a starting point for discussion regarding the use of previously researched physics learning change models in physics education and for identifying trends and recommendations for future research in this emerging field of research.

Recommendations

Based on the results of a systematic literature review on the use of Artificial Intelligence (AI) in engineering and scientific reasoning, the following strategic steps are recommended: Strengthening AI Integration in Engineering and Science Education Curriculum, Prioritizing Inquiry-Based Learning Models and Problem Solving, Conducting Long-Term Research on the Impact of AI, Designing Flexible and Responsive Teaching Methods for AI, Expanding AI Learning Activities Beyond the Formal Scope.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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