

A Comprehensive Guide for Conducting a Rigorous Systematic Literature Review (SLR)

By

Isaac Kofi Nti

Presentation Outline

1. Introduction
2. Understanding Systematic Literature Reviews (SLR)
3. Defining the Research Scope
4. Systematic Review Process: Key Steps
5. Searching and Selecting Relevant Literature
6. Screening and Quality Assessment of Studies
7. Data Extraction and Synthesis
8. Data Analysis and Interpretation
9. Writing and Reporting a Systematic Literature Review
10. Hands-on Activity and Discussion
11. Addressing Common Challenges in SLR
12. Q&A and Final Thoughts



Day 1 Overview

- Day 1 of this workshop begins with an **introduction to literature reviews**, explaining their purpose and differentiating between systematic, narrative, and bibliometric reviews while highlighting the significance of systematic literature reviews (SLR) in research. It then moves to **defining the research scope**, guiding participants in identifying an area of interest, formulating research questions using the **PICO and SPIDER frameworks**, and setting clear research objectives. Next, the module covers **systematic review protocols**, outlining the essential steps in conducting an SLR and introducing the **PRISMA framework** for study selection.
- Participants will then learn about **searching and selecting literature**, including how to develop structured search strategies using Boolean operators, truncation, and synonyms while selecting relevant academic databases such as **Scopus, Web of Science, IEEE Xplore, and Google Scholar**. This is followed by a **screening and quality assessment** module, where studies are evaluated using the **PRISMA flow diagram** and quality assessment tools like **Cochrane RoB, CASP, AMSTAR, and NOS** to ensure rigor and reliability. The module then delves into **data extraction and synthesis**, covering qualitative approaches such as **Thematic Analysis and Coding** as well as quantitative approaches like **Meta-Analysis and Statistical Evaluation**.
- The **data analysis and interpretation** segment introduces **trend analysis, geographical distribution analysis, and methodological assessment**, helping participants synthesize key findings and identify research gaps. Following this, the module focuses on **reporting findings and writing an SLR**, guiding participants on structuring their review, discussing **implications and recommendations**, and addressing common challenges. The session concludes with a **hands-on activity and discussion**, where participants will formulate research questions, practice Boolean search strategies in Google Scholar, and share their selected studies and quality assessments. This structured approach ensures a **comprehensive, step-by-step learning experience**, equipping participants with the necessary skills to conduct a **rigorous systematic literature review** effectively.

Learning Outcomes

- By the end of this session, participants will be able to:
 1. **Differentiate between various types of literature reviews**, including systematic, narrative, and bibliometric reviews.
 2. **Explain the importance of systematic literature reviews (SLR)** in academic research, particularly in ensuring transparency, reproducibility, and objectivity.
 3. **Apply systematic review protocols**, including defining research questions using **PICO and SPIDER frameworks**.
 4. **Develop and implement a structured search strategy**, incorporating Boolean operators, truncation, and synonyms for comprehensive literature retrieval.
 5. **Establish inclusion and exclusion criteria** to select high-quality, relevant studies for systematic review.
 6. **Use the PRISMA framework** to screen and document the study selection process systematically.
 7. **Conduct qualitative and quantitative data synthesis**, utilizing thematic analysis, meta-analysis, and coding techniques.
 8. **Assess the quality of selected studies** using established tools such as **Cochrane Risk of Bias (RoB), CASP, AMSTAR, and Newcastle-Ottawa Scale (NOS)**.
 9. **Analyze extracted data using trend analysis, geographical distribution, and methodological assessment techniques**.
 10. **Identify research gaps and future directions** based on synthesized findings and propose recommendations for further research.



Who am I?



Assistant Professor

School of Information Technology,
University of Cincinnati, Ohio, USA
PhD in Computer Science, MSc IT



Email:

ntious1@gmail.com
isaac.nti@uc.edu
isaac.nti@uenr.edu.gh



Research profile

Have published over 50 articles in high reputable journals and conferences
Over 1700+ citations from the scientific community

ORCID: [0000-0001-9257-4295](https://orcid.org/0000-0001-9257-4295)

Web of Science Researcher ID: [E-2004-2017](https://www.webofscience.com/authors/E-2004-2017)

Scopus Author ID: [57210637914](https://www.scopus.com/authid/detail.uri?authorId=57210637914)

SciProfiles: [698726](https://sciprofiles.com/authors/698726)

LinkedIn

[Website](#)



Why literature review?

- **A literature review is a structured summary of existing research on a topic.**
- **WHY?:**
 - Knowledge of existing research
 - Establishing the rationale
 - Avoiding duplication
 - Identifying research methods
 - Framing research questions
 - Building on previous work
 - Recognizing controversies and debates
 - Identifying gaps in knowledge
 - Strengthening credibility

Types of Literature Reviews

Traditional/Narrative Review

- Summarizes existing research with no strict methodology.

Systematic Review

- Follows a structured and reproducible process.
- Identifies, evaluates, and synthesizes relevant studies.

Bibliometric Review

- Uses statistical methods to analyze research impact and trends.
- Includes citation analysis, co-citation analysis, and network mapping.



Systematic Literature Review (SLR)

- **A systematic literature review is a rigorous and comprehensive approach to**
 - identifying,
 - evaluating, and
 - synthesizing existing research studies on a specific topic or research question.
- **It follows a predefined and systematic process to ensure**
 - objectivity,
 - transparency, and
 - reproducibility of the review's findings.

Importance of Systematic Literature Reviews



Ensures transparency and reproducibility.



Minimizes bias and improves research quality.



Helps in identifying research gaps and new directions.



Supports evidence-based decision-making.

Systematic Review Protocols

- **Step 1:** Define the research question (using PICO or SPIDER frameworks).
- **Step 2:** Develop inclusion and exclusion criteria.
- **Step 3:** Conduct a structured search in multiple databases.
- **Step 4:** Screen and select relevant studies (PRISMA Flow Diagram).
- **Step 5:** Extract, analyze, and synthesize findings.

Step 1

Define the research question (using PICO or SPIDER frameworks).

Define research scope

Why Starting from an Area of Interest is Important?

- 1. Sustained Motivation** – Research is a long-term commitment and choosing a topic you're passionate about will keep you engaged.
- 2. Deep Understanding** – Your prior knowledge and interest in the subject will make it easier to identify gaps and formulate insightful questions.
- 3. Relevance & Contribution** – If you select a topic within your area of expertise, you are more likely to contribute valuable findings to your field.
- 4. Networking & Collaboration** – Working in a field of interest allows you to connect with experts, attend relevant conferences, and access specialized resources.

How to Move from Interest to a Researchable Topic?

- 1 Broad Interest** → *AI in Education*
- 2 Subfield Selection** → *AI in Student Assessment*
- 3 Identify a Problem** → *Bias & Effectiveness in AI Grading*
- 4 Formulate a Research Topic** → *"Ethical & Practical Challenges of AI in Student Assessments"*
- 5 Define Research Questions** → *Effectiveness, Bias, Equity, Perceptions*

Alternative Approaches to Finding a Research Topic

If you're unsure about your area of interest, here are other strategies:

- Review Current Literature** – Look at recent studies, systematic reviews, and conference proceedings.
- Identify Practical Problems** – Talk to educators, students, or AI developers to see what challenges they face.
- Follow Emerging Trends** – Technologies like ChatGPT, adaptive learning, and AI ethics in education are hot topics.
- Consult Experts** – Professors, industry professionals, and peers can provide insights into gaps in the field.



Finalize Research Topic

A Systematic Literature Review on the Applications, Impacts, Challenges, and Future Trends of Artificial Intelligence in Education

Activity 1

- Get a research area of your interest and formulate a topic
- Share your topic in the chat.



Step 1: Formulate Research Questions (PICO/SPIDER)

Your review starts with a well-defined research question or a set of specific objectives to guide the process

- ✓ Clearly define the research question or objective of the literature review.
- ✓ Ensure that the question or objective is specific, focused, and answerable or achievable.

PICO and SPIDER Frameworks

PICO

- PICO is primarily used for formulating clinical research questions, especially in quantitative studies. It stands for:
 - **P** (Population/Problem): The group of people or problem being studied.
 - **I** (Intervention/Exposure): The treatment, intervention, or factor being examined.
 - **C** (Comparison): The alternative to the intervention (if applicable).
 - **O** (Outcome): The effect or result being measured.
- **Example (Medical Research)**
 - **Question:** Does mindfulness meditation reduce anxiety in college students compared to no intervention?
 - **P:** College students with anxiety
 - **I:** Mindfulness meditation
 - **C:** No intervention
 - **O:** Reduction in anxiety levels

SPIDER

- SPIDER is an alternative to PICO, often used for **qualitative** and mixed-methods research. It focuses on broader aspects like study design and evaluation. It stands for:
 - **S** (Sample): The target population or group.
 - **PI** (Phenomenon of Interest): The experience, behavior, or topic being explored.
 - **D** (Design): The type of study or methodology.
 - **E** (Evaluation): The outcome measures or themes observed.
 - **R** (Research Type): The study methodology (qualitative, quantitative, or mixed).
- **Example (Education Research)**
 - **Question:** How do students perceive online learning during the pandemic?
 - **S:** University students
 - **PI:** Online learning experiences
 - **D:** Surveys and interviews
 - **E:** Student perceptions and challenges
 - **R:** Qualitative

Key Differences

Feature	PICO	SPIDER
Best for	Clinical/quantitative research	Qualitative & mixed-methods research
Focus	Intervention-based studies	Perceptions, behaviors, and experiences
Outcome	Measurable results (e.g., effectiveness of a treatment)	Subjective experiences & themes



How To Formulate A Research Question

Let's formulate four (4) research questions using SPIDER farmwork for the proposed research topic.

- A Systematic Literature Review on the Applications, Impacts, Challenges, and Future Trends of Artificial Intelligence in Education

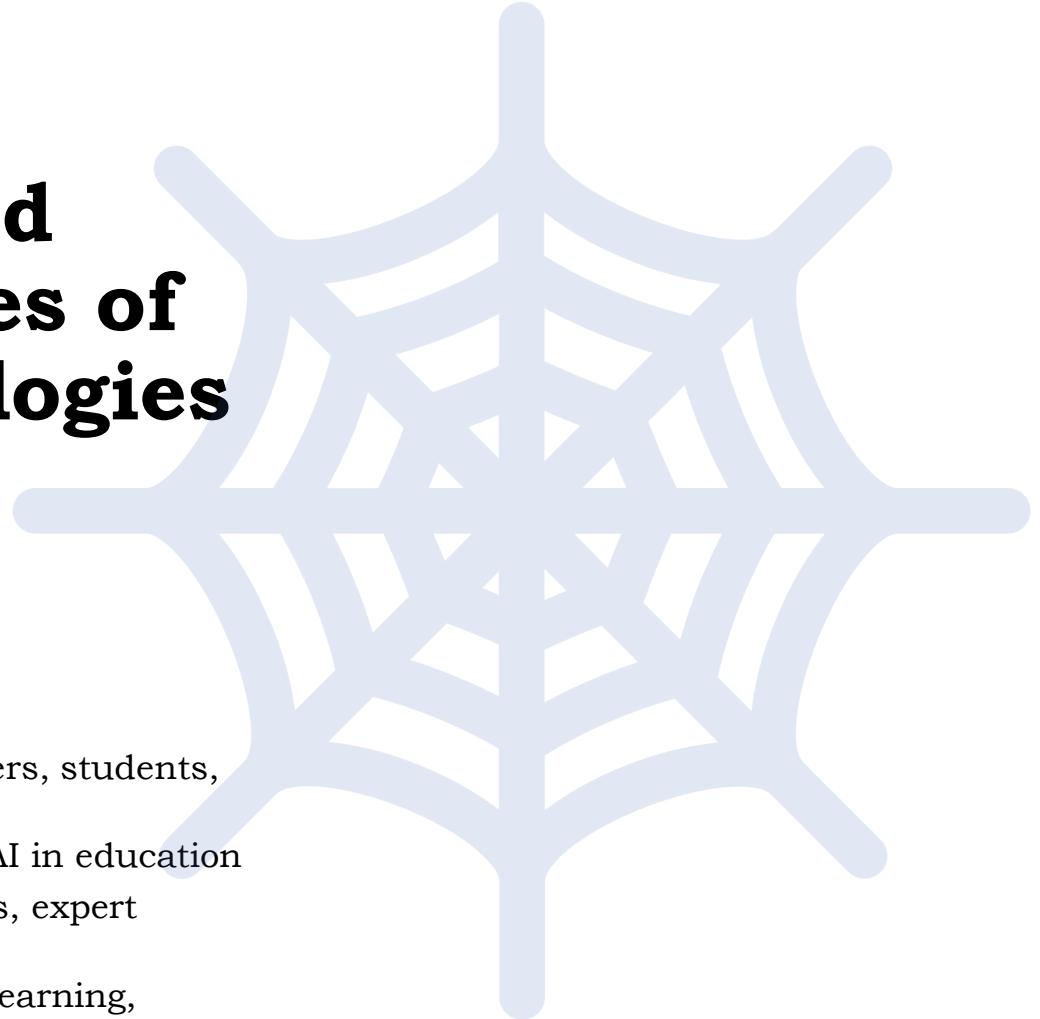
How are AI technologies applied in different educational settings, and what are their primary functions?

SPIDER Breakdown

- **S (Sample):** Educational institutions (schools, universities, online learning platforms)
- **PI (Phenomenon of Interest):** Applications of AI in education
- **D (Design):** Literature review, case studies, expert interviews
- **E (Evaluation):** Identification of AI applications (e.g., adaptive learning, intelligent tutoring, automated grading)
- **R (Research Type):** Qualitative and mixed-methods



What are the perceived benefits and challenges of integrating AI technologies into educational environments?



SPIDER Breakdown

- **S (Sample):** Educational institutions, teachers, students, and administrators
- **PI (Phenomenon of Interest):** Adoption of AI in education
- **D (Design):** Literature review, policy analysis, expert opinions, case studies
- **E (Evaluation):** Benefits (e.g., personalized learning, efficiency) and challenges (e.g., data privacy, teacher replacement concerns)
- **R (Research Type):** Qualitative and mixed-methods

What are the observed effects of AI implementation on teaching methodologies and student learning experiences?

SPIDER Breakdown

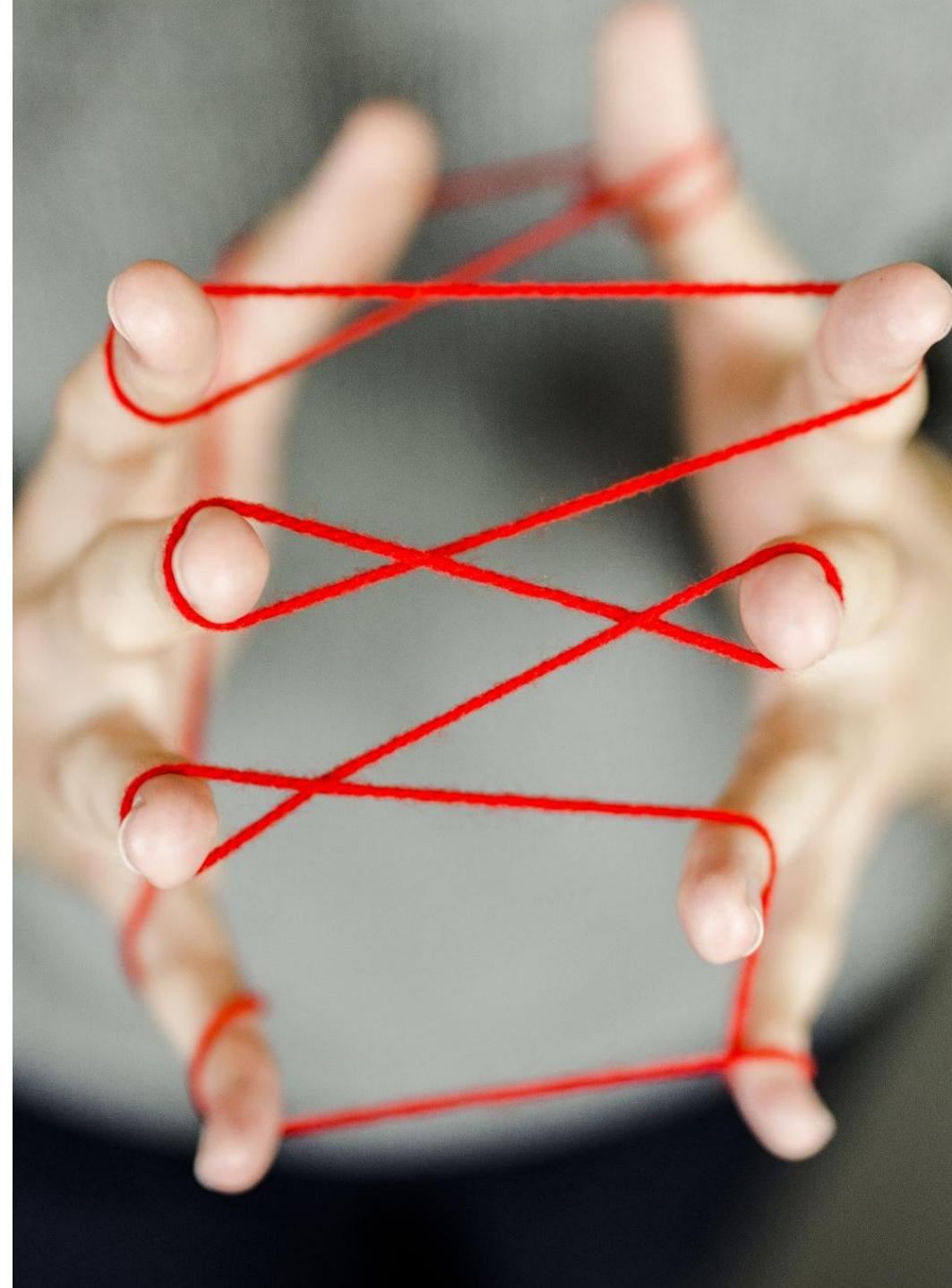
- **S (Sample):** Educators and students in AI-integrated learning environments
- **PI (Phenomenon of Interest):** Impact of AI on teaching and learning
- **D (Design):** Empirical studies, surveys, interviews, literature review
- **E (Evaluation):** Changes in pedagogy, student engagement, learning outcomes
- **R (Research Type):** Qualitative and mixed-methods



What are the emerging trends and potential future advancements in AI-driven educational technologies?

SPIDER Breakdown

- **S (Sample):** AI researchers, educators, policymakers, ed-tech companies
- **PI (Phenomenon of Interest):** Future trends and advancements in AI for education
- **D (Design):** Expert interviews, literature review, Delphi studies, trend analysis
- **E (Evaluation):** Predicted innovations, technological advancements, AI-driven policy changes
- **R (Research Type):** Qualitative and foresight research



Research Objectives For Q1 & Q2

1. How are AI technologies applied in different educational settings, and what are their primary functions?

- **SLR-Specific Objectives**

- To systematically identify and categorize existing AI applications in education.
- To analyze AI implementation across different educational levels (e.g., K-12, higher education, online learning).
- To synthesize findings on the primary roles and functions of AI in education based on existing studies.

2. What are the perceived benefits and challenges of integrating AI technologies into educational environments?

- **SLR-Specific Objectives**

- To systematically review literature on the benefits of AI in teaching, learning, and administration.
- To identify common challenges and barriers to AI adoption in education.
- To analyze case studies and research findings comparing AI adoption experiences in different educational settings.
- To synthesize recommendations from prior studies for improving AI implementation in education.

Research Objectives For Q3 & Q4

- 3. What are the observed effects of AI implementation on teaching methodologies and student learning experiences?**
 - 4. What are the emerging trends and potential future advancements in AI-driven educational technologies?**
-
- **SLR-Specific Objectives**
 - To review empirical studies on the impact of AI on teaching strategies and instructional methods.
 - To analyze how AI influences student engagement, motivation, and academic performance.
 - To synthesize educators' and students' perspectives on AI-enhanced teaching and learning.
 - To identify recurring themes related to AI-related challenges and opportunities in the literature.
 - **SLR-Specific Objectives**
 - To systematically analyze literature on emerging AI trends in education.
 - To identify predicted advancements in AI-driven educational tools and methodologies.
 - To examine expert perspectives and foresight studies on AI's future role in education.
 - To provide a synthesized discussion on potential policy and technological recommendations based on existing research.

Activity 2

Formulate 2 research questions
based on your topic in activity 1
using the SPIDER framework and
share in the chat

PRISMA Flow Diagram

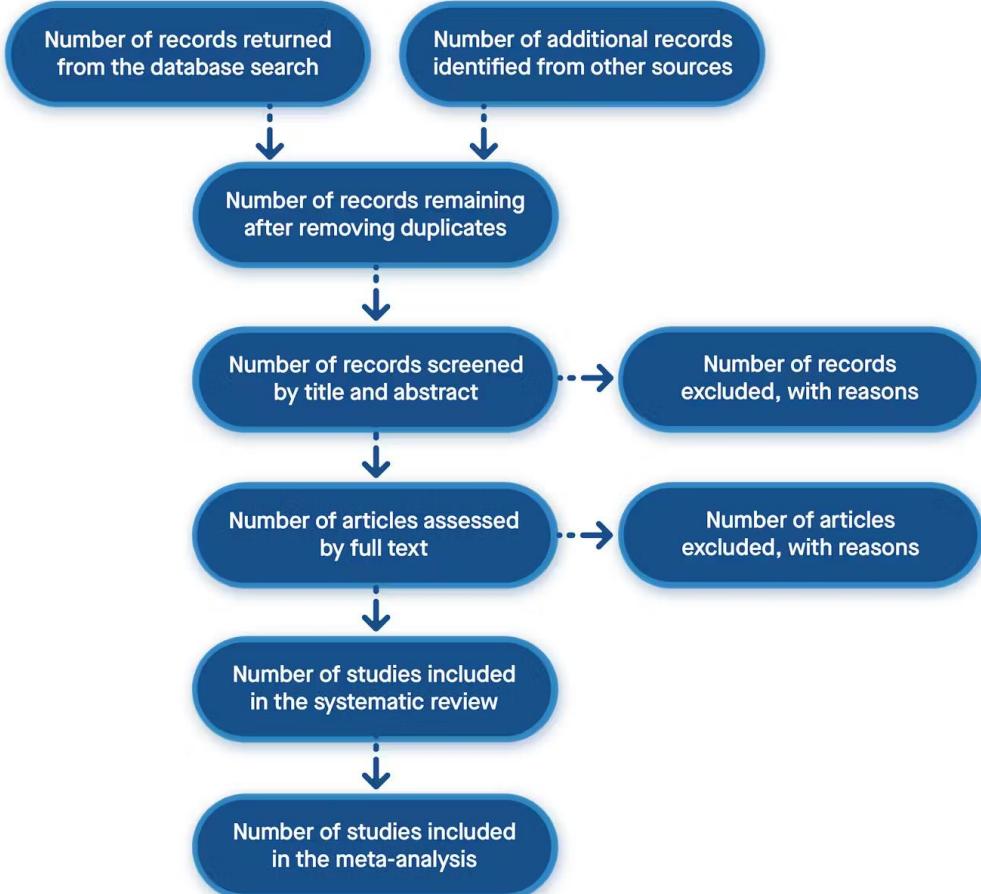
- A PRISMA flow diagram is an image that shows the flow of information in a systematic review or meta-analysis

Identification

Screening

Eligibility

Inclusion



Step 2

Develop inclusion and exclusion criteria.



Develop an Inclusion, Exclusion Criteria

- Define your inclusion and exclusion criteria to select studies that meet specific eligibility requirements.
 - This ensures that the studies chosen are relevant and meet the review's criteria.





Inclusion Criteria

- Studies published in **peer-reviewed journals or conferences**
- Studies from **2015-present** (latest AI advancements)
- Papers **written in English**
- Studies with **Full-Text Availability**
- Research focused on **AI applications in education**
- Studies discussing **challenges, benefits, and future trends**



Exclusion Criteria

✗ Non-Educational AI Research

- Studies that focus on AI development but do not discuss its **applications in education**.

✗ Non-Peer-Reviewed Sources

- Opinion pieces, blog posts, preprints, white papers, and **non-peer-reviewed articles**.

✗ Older Studies (Before 2015)

- Unless they are **foundational** works that contribute significantly to the field.

✗ Non-English Papers

- Studies that are **not available in English** and do not have a **verified English translation**.

✗ Studies Without Full-Text Access

- Abstracts or partial-access papers that **do not provide enough information** for analysis.

✗ Duplicate Studies

- Repeated publications of the **same study** across different sources will be removed.

By applying these inclusion and exclusion criteria, the systematic literature review will ensure that the selected studies are relevant, methodologically sound, and contribute valuable insights to the understanding of artificial intelligence applications in education.

III

Step 3: Conduct a structured search in multiple databases.



Define Research Scope & Keywords

Main Keywords and Synonyms

1. Artificial Intelligence in Education
2. AI Applications in Teaching and Learning
3. Machine Learning for Student Engagement
4. Intelligent Tutoring Systems
5. AI-Driven Personalized Learning
6. Impact of AI on Education
7. Challenges of AI in Teaching and Learning
8. Ethical Concerns in AI-Powered Education
9. Future Trends in AI and Education
10. Adaptive Learning Technologies

Concept	Keywords & Synonyms
AI / Artificial Intelligence	"Artificial Intelligence" OR "AI" OR "Machine Learning" OR "Deep Learning" OR "Natural Language Processing" OR "Educational Data Mining" OR "Learning Analytics"
Education	"Education" OR "Teaching" OR "Learning" OR "Higher Education" OR "K-12" OR "Online Learning" OR "Distance Learning"
Applications	"AI Applications" OR "AI Tools" OR "EdTech" OR "Adaptive Learning" OR "Intelligent Tutoring" OR "Automated Assessment" OR "Chatbots"
Impact	"Effect" OR "Influence" OR "Impact" OR "Outcomes" OR "Student Engagement" OR "Teaching Effectiveness"
Challenges	"Barriers" OR "Challenges" OR "Ethical Issues" OR "Privacy" OR "Equity"
Future Trends	"Emerging Trends" OR "Future of AI" OR "Advancements" OR "Next-Generation AI"

You can use [Google trends](#) to get suggested keywords based on your developed keywords

Activity 3

Defined 6 keyword based on your research questions or objectives and share in the chat

Databases & Search Engines

- Identify Databases & Search Engines
 - Database
 - [Scopus](#),
 - [ACM Digital Library](#),
 - [Web of Science](#),
 - [IEEE Xplore](#),
 - [PubMed](#),
 - etc.
 - Search Engines
 - [Google Scholar](#),
 - [Microsoft Academic](#),
 - [BASE](#),
 - [Semantic Scholar](#), etc.), and other sources to search for scholarly articles.
- Develop a comprehensive search strategy using your keywords, Boolean operators, and advanced search techniques.

Search Literature With Boolean Search Queries (1)

• **Basic search query:** Start with a basic search query using all the keywords connected by the OR operator

- Artificial Intelligence OR AI OR "Machine Learning" OR "Deep Learning" OR "Natural Language Processing" OR "Educational Data Mining" OR "Learning Analytics" OR "Intelligent Tutoring Systems" OR "Chatbots" OR "Adaptive Learning" OR "Automated Assessment"

• **Refine the search:** Use Boolean operators (AND, OR) and parentheses to group related terms, ensuring a more structured and targeted search.

• ("Artificial Intelligence" OR AI OR "Machine Learning" OR "Deep Learning" OR "Natural Language Processing" OR "Educational Data Mining" OR "Learning Analytics") AND ("Education" OR "Teaching" OR "Learning" OR "Higher Education" OR "K-12" OR "Online Learning" OR "Distance Learning") AND ("Application" OR "Implementation" OR "Integration" OR "Adoption" OR "Impact" OR "Effectiveness" OR "Challenges" OR "Trends")

• **Utilize Truncation or Wildcards:** Use truncation (*) to capture different word variations (e.g., "learn*" retrieves "learning" and "learner").

• ("Artificial Intelligence" OR AI OR "Machine Learn*" OR "Deep Learn*" OR "Natural Language Process*" OR "Educational Data Min*" OR "Learning Analytic*") AND ("Educat*" OR "Teach*" OR "Learn*" OR "Higher Educat*" OR "Online Learn*" OR "Distance Learn*") AND ("Applic*" OR "Implement*" OR "Integrat*" OR "Adopt*" OR "Impact*" OR "Effective*" OR "Challeng*" OR "Trend*")

Search Literature With Boolean Search Queries (2)

- **Include Synonyms or Related Terms:** Expand coverage by incorporating synonyms and related terms.
 - ("Artificial Intelligence" OR AI OR "Machine Learning" OR "Deep Learning" OR "Neural Networks" OR "Natural Language Processing" OR "Educational Data Mining" OR "Learning Analytics" OR "Intelligent Tutoring Systems" OR "Adaptive Learning" OR "Automated Grading" OR "Chatbots" OR "AI-powered Education") AND ("Education" OR "Teaching" OR "Pedagogy" OR "Instruction" OR "Higher Education" OR "K-12" OR "E-learning" OR "Online Learning" OR "Blended Learning") AND ("Application" OR "Implementation" OR "Adoption" OR "Use Cases" OR "Impact" OR "Effectiveness" OR "Challenges" OR "Barriers" OR "Ethical Concerns" OR "Equity Issues" OR "Trends" OR "Future Directions")
- **Specific Phrases (Exact Matches Using Quotation Marks):** Use quotation marks (" ") to find exact phrases and prevent irrelevant results.
 - ("Artificial Intelligence" OR AI OR "Machine Learning" OR "Deep Learning" OR "Natural Language Processing" OR "Educational Data Mining" OR "Learning Analytics" OR "Intelligent Tutoring Systems" OR "Adaptive Learning" OR "Automated Assessment" OR "AI in Education") AND ("Higher Education" OR "Online Learning" OR "K-12 Education" OR "Distance Learning" OR "Digital Education") AND ("Impact on Student Engagement" OR "Personalized Learning" OR "AI-powered Tutoring" OR "Challenges in AI Adoption" OR "Ethical Concerns in AI Education" OR "Future of AI in Education")

Search Literature With Boolean Search Queries (3)

Experiment with Variations: Try different combinations to ensure comprehensive literature coverage

- **Variation 1: Focusing on AI Applications in Education**
 - ("Artificial Intelligence in Education" OR "AI in Education" OR "Machine Learning in Teaching" OR "Deep Learning in Learning" OR "Educational Data Mining Applications") AND ("Adaptive Learning Systems" OR "Personalized Learning with AI" OR "AI-powered Assessment" OR "Automated Grading" OR "AI Chatbots in Education")
- **Variation 2: Focusing on AI Challenges and Ethical Concerns**
 - ("Artificial Intelligence in Education" OR "AI in Education" OR "Machine Learning in Teaching" OR "Deep Learning in Learning") AND ("Challenges in AI Implementation" OR "Ethical Issues in AI" OR "Bias in AI-driven Education" OR "Equity Concerns in AI Applications")
- **Variation 3: Focusing on Future Trends in AI and Education**
 - ("Artificial Intelligence in Education" OR "AI in Education" OR "Machine Learning in Teaching" OR "Deep Learning in Learning") AND ("Future Trends in AI Education" OR "Next-Generation AI in Learning" OR "AI-powered Smart Classrooms" OR "Emerging AI Applications in Teaching")

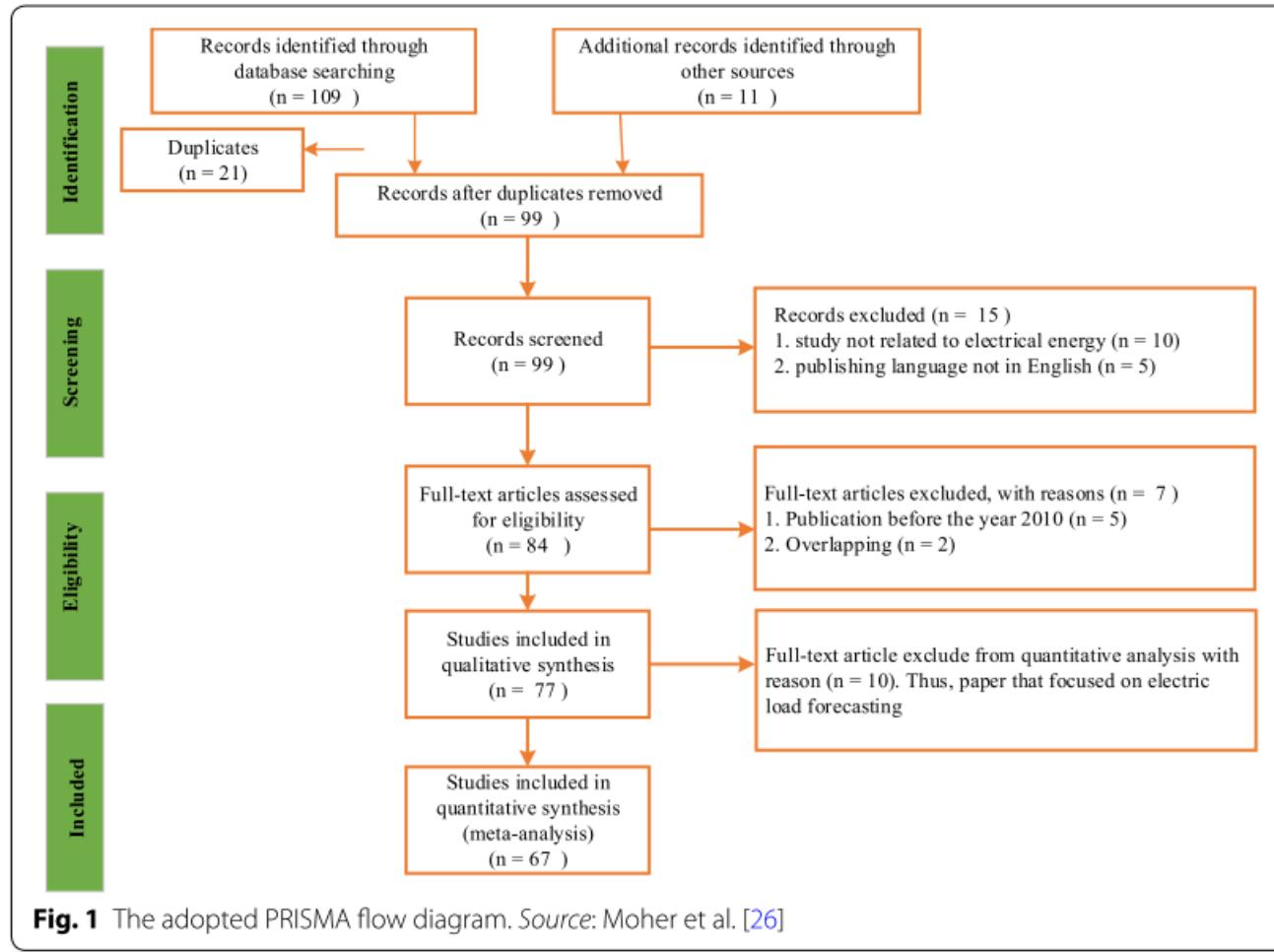
Activity 4

Search Google scholar with your defined keywords and share the outcome in the chat

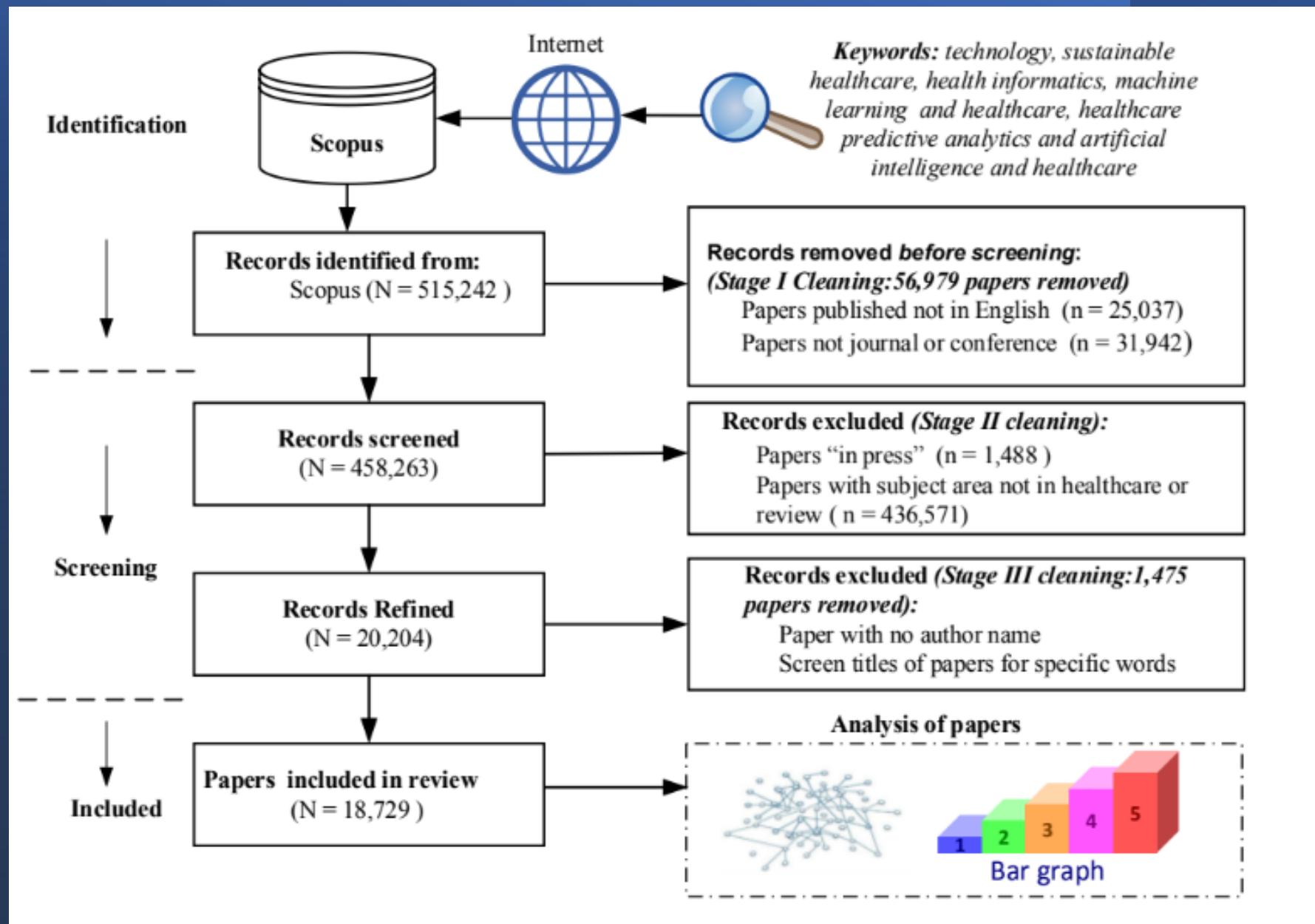
Step 4

Screen and select relevant studies (PRISMA Flow Diagram).

Sample's of PRISMA framework



Nti, I. K., Teimeh, M., Nyarko-Boateng, O., & Adekoya, A. F. (2020). Electricity load forecasting: a systematic review. Journal of Electrical Systems and Information Technology (13), 1–19. <https://doi.org/10.1186/s43067-020-00021-8>



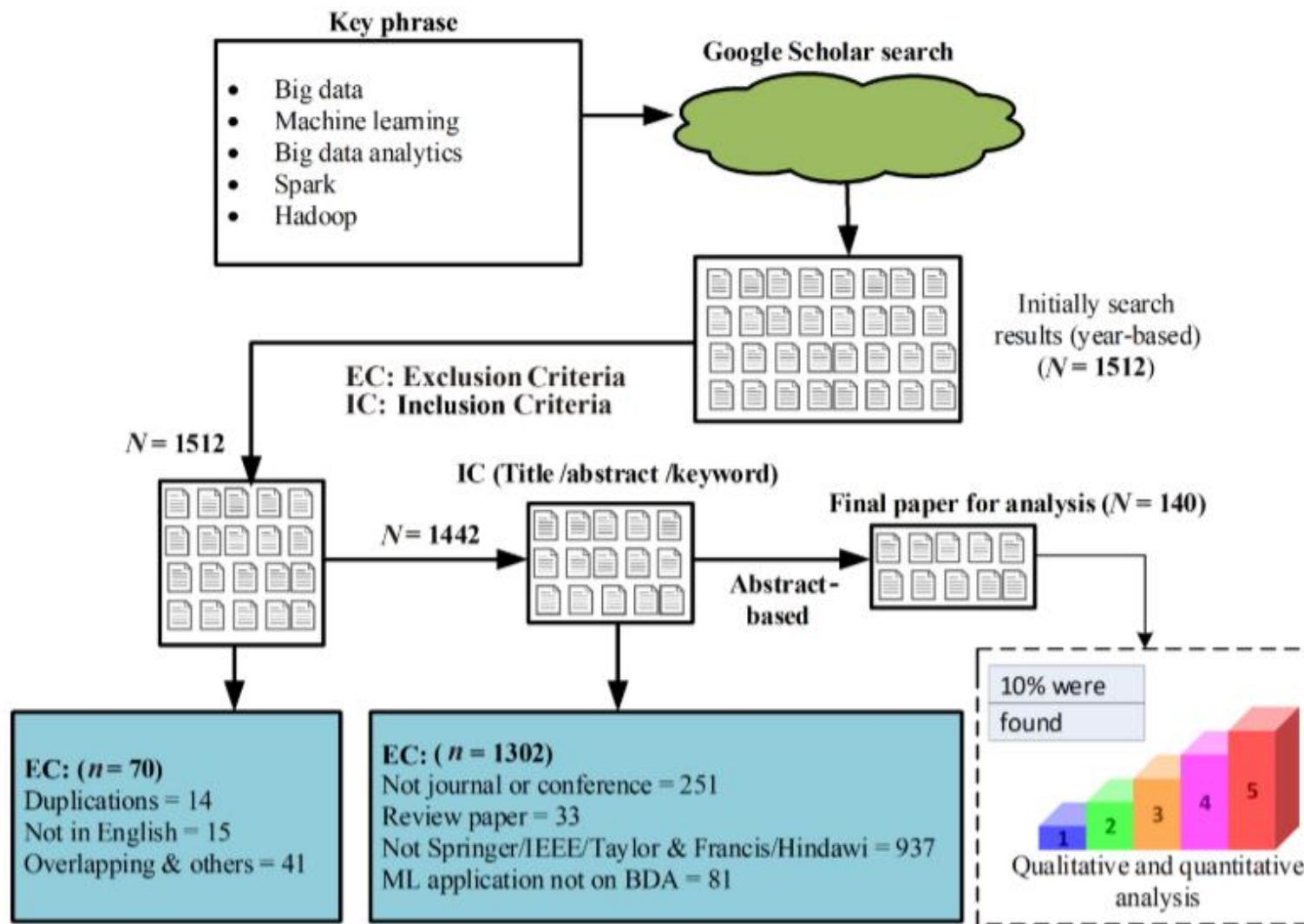


Fig. 4 Systematic literature review process.

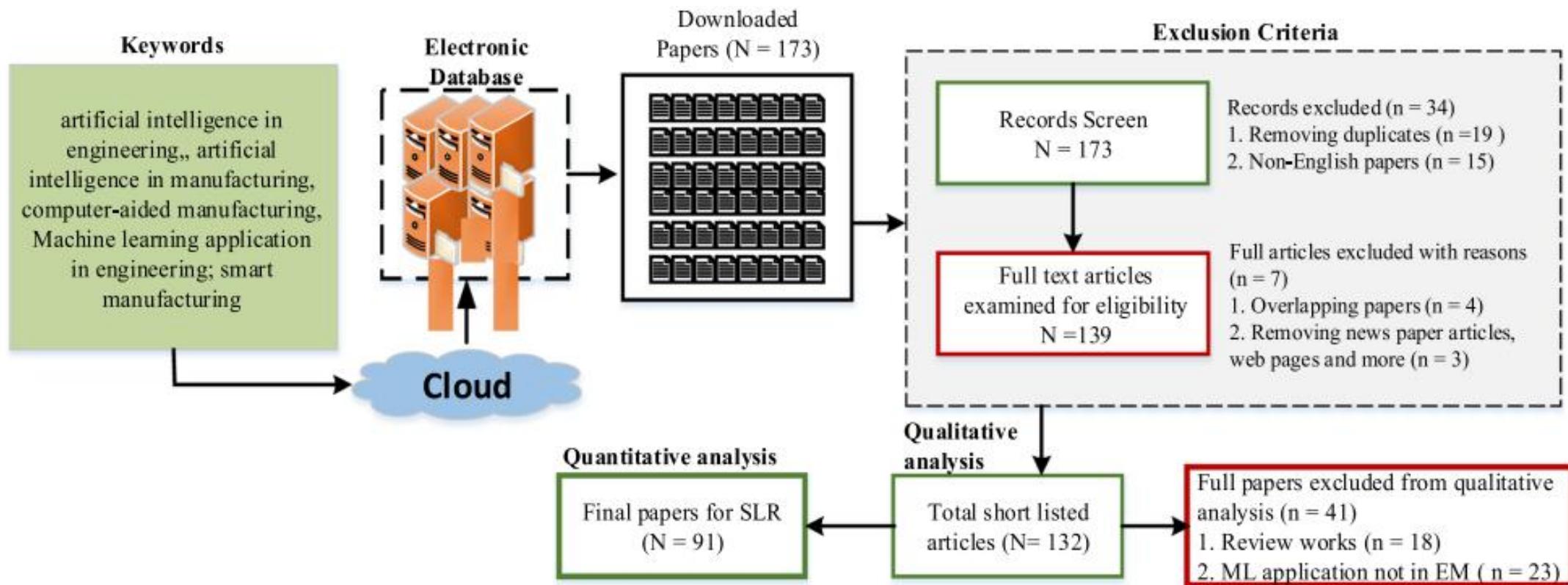


Fig. 3 Framework for paper selection

Activity 5

- Briefly evaluate studies from your Google Scholar search and decide which 10 papers to include and which two to exclude.
- Share the DOI of these papers in the chat.

Quality Assessment of Selected Studies

1. Evaluate the quality, reliability, and validity of the selected studies.
1. Use appropriate quality assessment tools or checklists for different study designs (e.g., **PRISMA guidelines**, Cochrane Collaboration's tools).
1. Assess the risk of bias, study limitations, and the overall quality of the evidence.

Common Quality Assessment Tools for Systematic Literature Reviews (SLR)

1. Cochrane Risk of Bias (RoB) Tool

- Designed for assessing **randomized controlled trials (RCTs)**.
- Evaluates bias in areas such as **random sequence generation, allocation concealment, blinding, incomplete data, and selective reporting**.
- **Use case:** If your SLR includes experimental studies on AI in education.

2. CASP (Critical Appraisal Skills Programme) Checklist

- A widely used tool for **qualitative research and cohort studies**.
- Includes **10-12 structured questions** that assess research validity, clarity, methodology, and applicability.
- **Use case:** Suitable for **case studies, surveys, and qualitative studies** on AI in education.

3. AMSTAR (A Measurement Tool to Assess Systematic Reviews)

- Specifically designed to assess **the quality of systematic reviews**.
- Evaluates **study selection, data extraction, risk of bias assessment, funding sources, and synthesis methods**.
- **Use case:** If your SLR includes **meta-analyses or reviews of reviews** on AI in education.

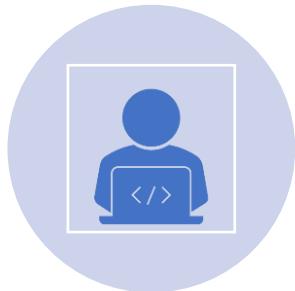
4. Newcastle-Ottawa Scale (NOS)

- Assesses **observational studies**, such as **case-control and cohort studies**.
- Scores studies based on **selection, comparability, and outcome assessment**.
- **Use case:** Best for **non-experimental studies** on AI adoption in education.

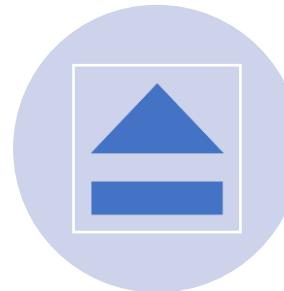
Sample Checklist for Evaluating Study Reliability

Criteria	Yes <input checked="" type="checkbox"/> / No <input type="checkbox"/>
1. Clear Research Question - Is the study's objective clearly stated?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
2. Appropriate Study Design - Is the research design suitable for the question?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
3. Sample Size Justification - Is the sample size sufficient and justified?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
4. Data Collection Methodology - Are the data collection methods well-explained?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
5. Data Sources Reliability - Are the sources credible and appropriate?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
6. Analysis Methodology - Is the data analysis method robust and appropriate?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
7. Findings Clearly Reported - Are results presented in a structured manner?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
8. Study Limitations Addressed - Does the study discuss its limitations?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
9. Ethical Considerations - Has ethical approval been obtained (if applicable)?	<input checked="" type="checkbox"/> / <input type="checkbox"/>
10. Peer-Reviewed Source - Is the study published in a peer-reviewed journal or conference?	<input checked="" type="checkbox"/> / <input type="checkbox"/>

Screening & Selection Process



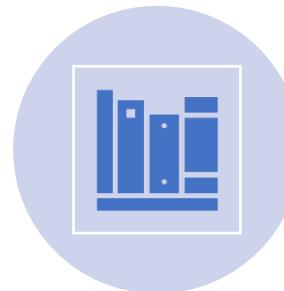
1. Import the search results into a reference management tool (e.g., Mendeley, Zotero, EndNote, RefWorks, and Citavi) or database.



2. Begin with the removal of duplicates and overlaps.



3. Screen the remaining articles based on their titles and abstracts, applying the inclusion and exclusion criteria (*assess their relevance to the research question*).



4. Retrieve and review the full-text articles of the potentially relevant studies (*determine their eligibility for inclusion in the review*)



Step 5

Extract, analyze, and synthesize findings.



Data Extraction



1. Develop a structured data extraction form or template to capture relevant information from each selected study.



2. Extract key details such as author(s), publication year, research methods, sample size, variables, evaluation metrics, findings, and any other relevant data.



3. Independently extract data from each study by multiple reviewers to ensure accuracy and consistency.



4. Resolve any discrepancies or disagreements in data extraction through discussion and consensus among the review team.

Data Analysis and Interpretation

- Let see some of the analyses you can performed on your extracted dataset

Trend & Geographical analysis (1)

Trend analysis

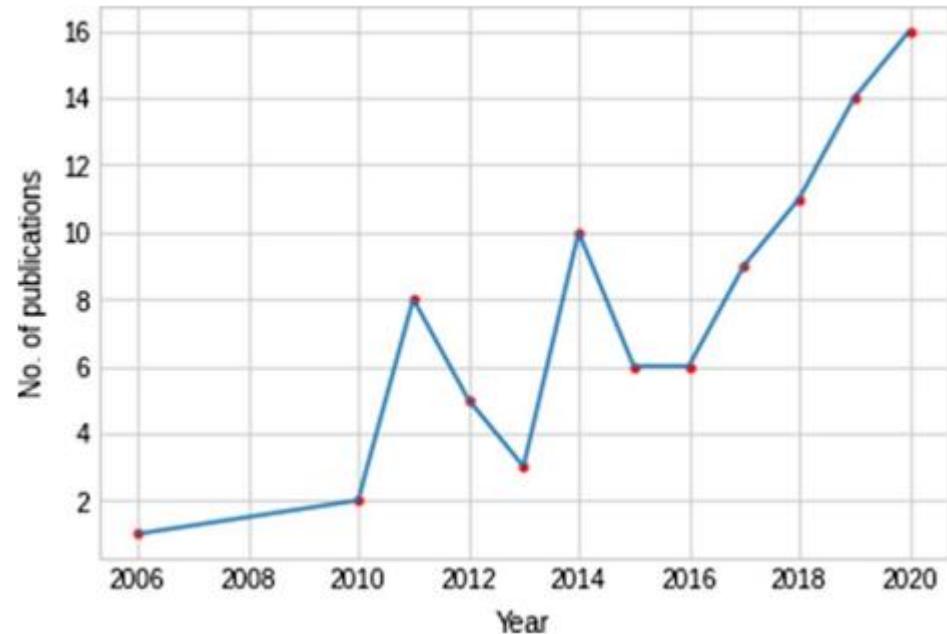
- Examine the publication trends over time to identify the growth of research on AI in education.
- It highlights emerging research areas and changes in research focus over different time periods.

Geographical Analysis

- Perform a geographical analysis to determine the distribution of research across different countries or regions.
- This analysis can reveal which countries are leading in AI applications in education research.



Fig. 8 Publication origin distribution.



Trend & Geographical analysis (2)

Table 6 Number of papers per publication type

Type of publication	No. of papers	%
Journal articles	68	75
Conference proceedings	21	23
Books & book chapters	1	1
Working papers and reports	1	1
Total	91	100

Methodological Analysis (1)

- Analyze the methodologies employed in the retrieved papers.
- Identify the types of research designs, data collection methods, and data analysis techniques used in the studies.

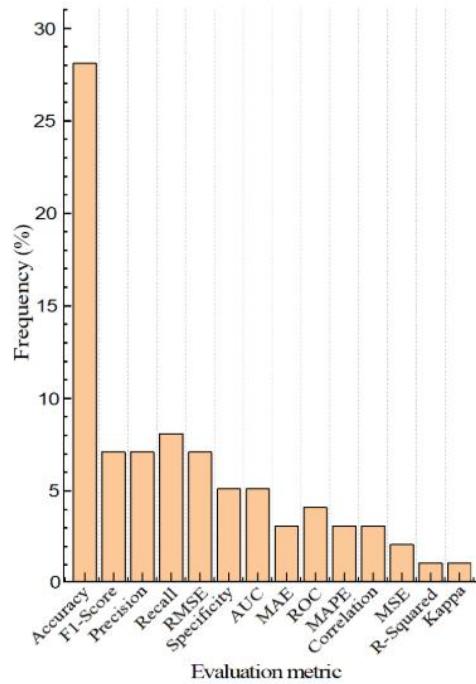


Fig. 9 Evaluation metric distribution.

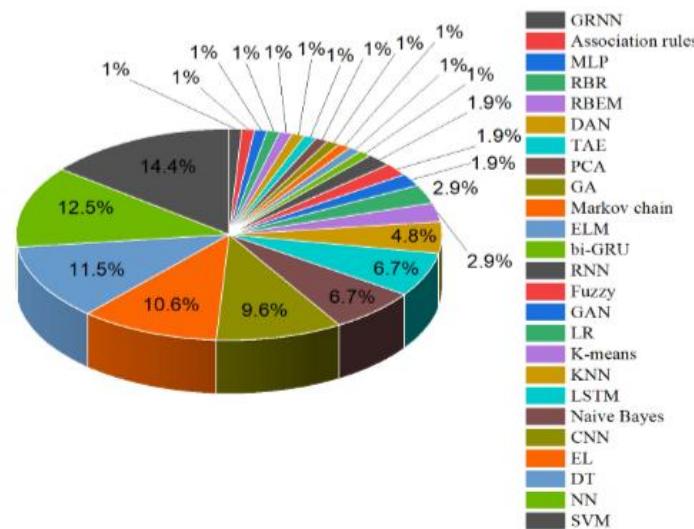


Fig. 7 ML techniques mainly used for BDA.

Table 2 BDA platforms and tools.

BD platforms and tools	Number of papers	Percentage (%)
Flink	1	2.33
Apache Mahout	1	2.33
HiBench	1	2.33
H2O	1	2.33
MATLAB	5	11.63
MapReduce	6	13.95
Apache Hadoop	13	30.23
Apache Spark	15	34.88

Methodologic al Analysis (2)

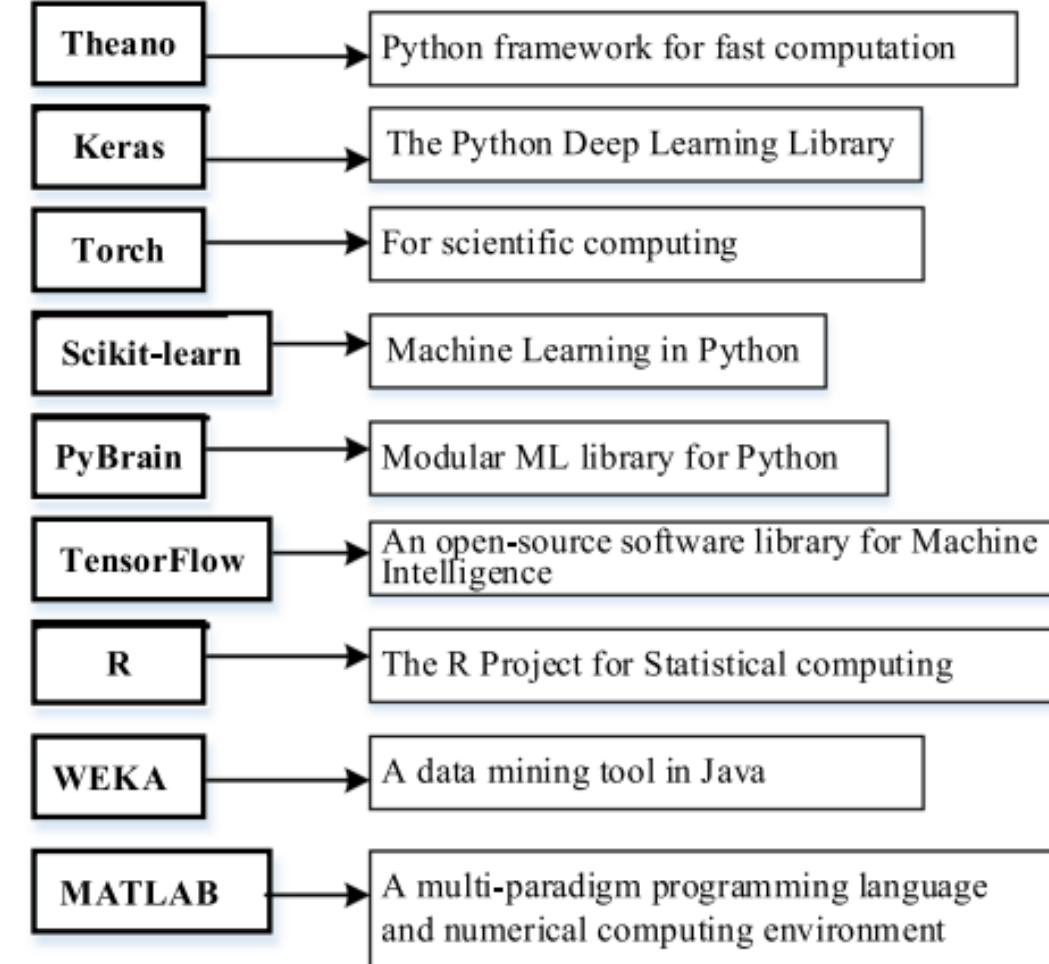


Fig. 12 Commonly used ML software and tool

Methodological Analysis (3)

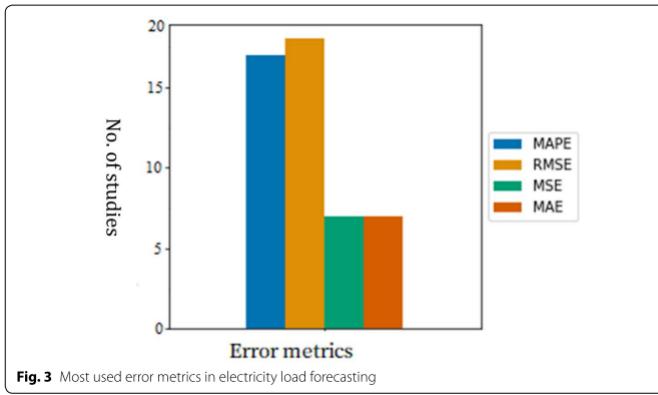
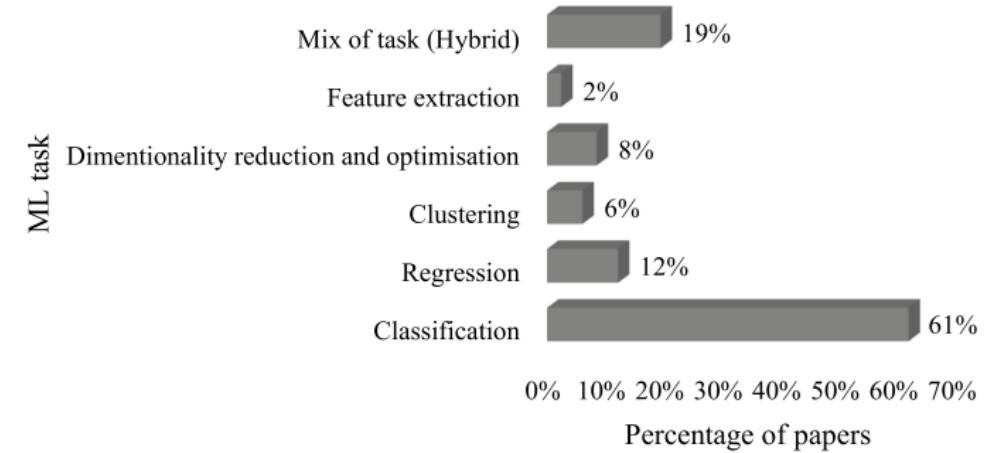


Fig. 9 Papers distribution based on ML task



A summary of studies

Table A1 A summary of reviewed papers.

No.	Reference	Application area	Objective	Data size
1.	[15]	Disaster (rain damage)	Proposed a forecasting model for heavy rain damage using ML and BD	528 521 data points
2.	[69]	Energy	Predicted offshore wind farm based on BD and ML algorithms	396 000 observations
3.	[70]	Healthcare	Predicted disease in healthcare using ML and BD	20 320 848 records
4.	[71]	E-commerce	Predicted consumer product demands using BD	35 203 observations
5.	[72]	NS	Optimised anomaly detection using BD	708 MB
6.	[73]	Cybersecurity	Detected and classified malicious command and reply packets in an SCADA network	64 100 instances
7.	[74]	Automobile, power system, and road weather dataset	Proposed an improvement in distance variable of time-series DB stream evaluation	34 435 268 instances
8.	[75]	NS	Proposed a Random Bit's Regression (RBR) as a predictor for DB	NA
9.	[76]	NS	Sentiment classification using Rule-Based Emission Model (RBEM)	12 809 observations
10.	[77]	Geochemical anomalies	Detected geochemical anomalies	NA
11.	[78]	Data privacy (wireless network)	Proposed and implemented an ML tactic for smart-edges based on differential privacy	222 048 observations
12.	[79]	Healthcare	Proposed a predictive framework for emergency biomedical BD using DL H ₂ O	35 233 samples
13.	[80]	Communication systems & network	Proposed a BD and ML-enabled wireless channel model	NA
14.	[81]	Transportation (traffic speed)	Predicted traffic speeds	70 000 samples
15.	[82]	Transportation	Identified unlicensed taxi using BDA	340 679 449 records

Content Analysis

- Conduct a content analysis of the retrieved papers to identify common themes, topics, and research areas related to AI applications in education.
 - Categorize the papers based on their primary focus and content.
-

1. Thematic Analysis (For Qualitative Synthesis)

Best for: Identifying key themes across studies based on qualitative findings.

Steps:

1. **Familiarization** – Read and re-read the selected studies.
 2. **Coding** – Assign codes to key findings related to your research questions.
 3. **Theme Identification** – Group similar codes into overarching themes (e.g., "AI-driven personalized learning").
 4. **Theme Refinement** – Merge or refine overlapping themes for clarity.
 5. **Reporting** – Present themes with supporting evidence from studies.
-  **Example Themes for AI in Education:**
 - AI for Personalized Learning
 - AI in Assessment & Feedback
 - Ethical Concerns of AI in Education

1. Thematic Analysis (2)

- The clustering process aims to group together papers that share similar characteristics, topics, or research objectives.
- some potential clusters:

• **AI in Pedagogy and Teaching Methods**

- Papers that explore how artificial intelligence is integrated into teaching methods and pedagogical approaches.
- Research on AI-driven personalized learning, adaptive learning platforms, and intelligent tutoring systems

• **AI in Educational Assessment and Evaluation:**

- Papers focusing on the use of AI in educational assessments and evaluations.
- Studies on automated grading systems, AI-based assessment tools, and intelligent exam proctoring.

1. Thematic Analysis (3)

• **Natural language processing (NLP) in language learning**

- Papers that investigate the use of NLP and AI technologies for language learning and language processing tasks.
- Research on language learning chatbots, language proficiency assessment using AI, and automated language feedback systems.

• **AI for educational data analysis and learning analytics**

- Papers related to the application of AI in analyzing educational data and learning analytics.
- Studies on AI-based data mining, predictive modeling for student performance, and educational data visualization.

• **Ethical and social implications of AI in education**

- Papers that examine the ethical considerations and social implications of AI adoption in educational settings.
- Research on AI bias in educational applications, privacy concerns, and equity issues in AI-driven education.

1. Thematic Analysis (4)

• **Ethical and social implications of AI in education**

- Papers that examine the ethical considerations and social implications of AI adoption in educational settings.
- Research on AI bias in educational applications, privacy concerns, and equity issues in AI-driven education.

• **AI in educational content creation and recommendation**

- Papers focusing on the use of AI in generating educational content and recommending resources.
- Studies on AI-driven content creation tools, personalized learning materials, and intelligent content curation.

• **Robotics and AI in STEM Education**

- Papers exploring the integration of robotics and AI technologies in STEM (Science, Technology, Engineering, and Mathematics) education.
- Research on robotics-based educational activities, AI-assisted coding instruction, and AI-driven simulations in science education.

1. Thematic Analysis (5)

AI for teacher support and professional development

- Papers that discuss the use of AI in supporting teachers' professional development and classroom practices.
- Studies on AI-driven teacher training, intelligent feedback for educators, and AI-based classroom management tools.

AI and virtual reality in education

- Papers that investigate the combination of AI and virtual reality technologies in educational contexts.
- Research on AI-driven VR simulations for experiential learning, AI-guided virtual tutors, and AI-enhanced virtual classrooms.

AI in educational policy and implementation

- Papers examining the policy implications and challenges of integrating AI in educational systems.
- Studies on AI adoption in educational institutions, policy frameworks, and guidelines for AI integration in education.

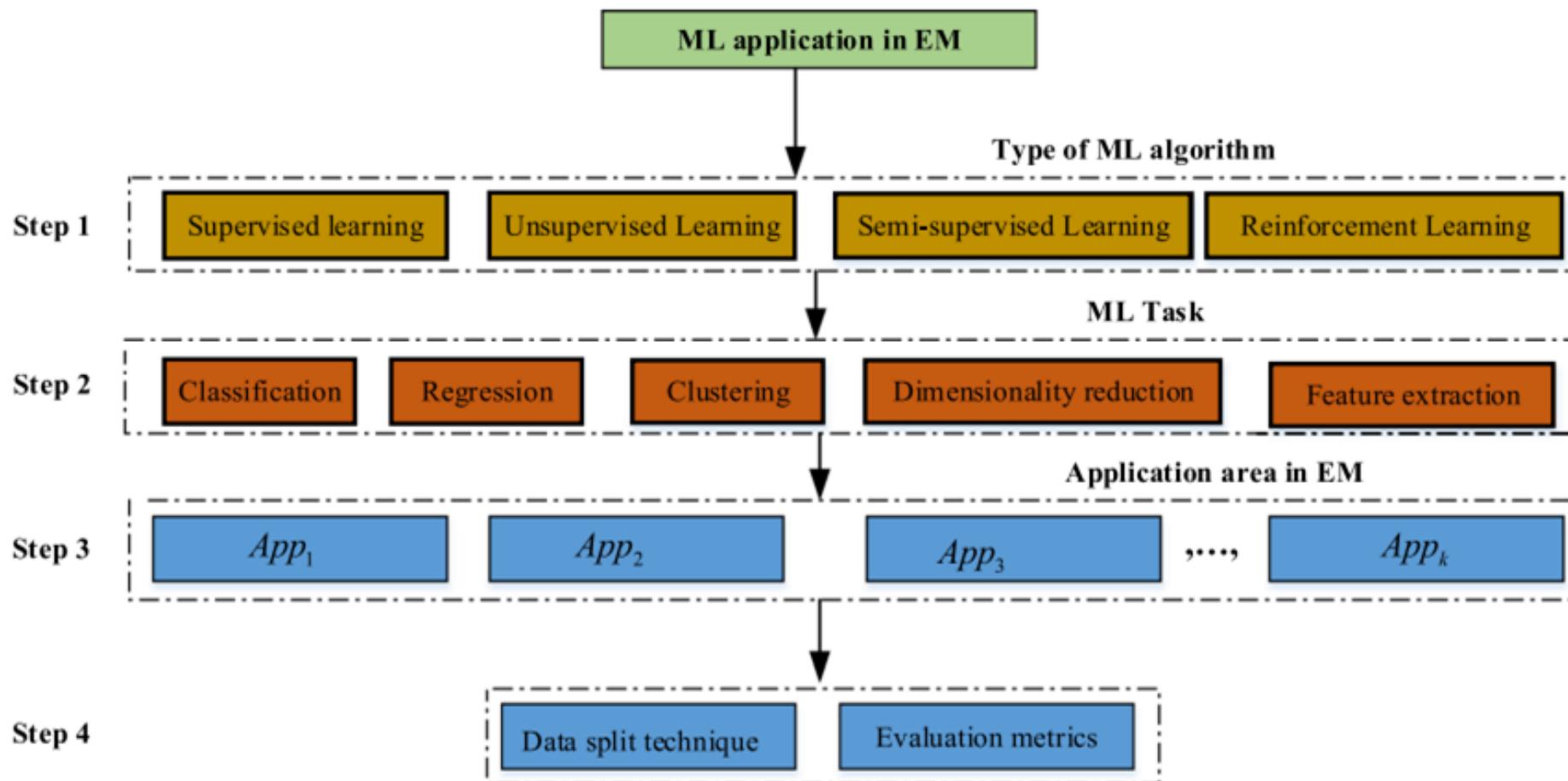


Fig. 7 Our SI.R framework

Table 7 AI application area in EM

APP	Description	No. of papers	(%)
<i>App₁</i>	Fault diagnostics	24	28.9
<i>App₂</i>	Manufacturing monitoring, cost, and power consumption	16	19.3
<i>App₃</i>	Robotics, autonomous computing and driving	9	10.8
<i>App₄</i>	Anomaly detection and predictive maintenance	6	7.2
<i>App₅</i>	Power system disturbance, grid, and cyber-attack discrimination	7	8.4
<i>App₆</i>	Production	6	7.2
<i>App₇</i>	Semiconductor and IC manufacturing	5	6.0
<i>App₈</i>	Machine vision	4	4.8
<i>App₉</i>	Fault diagnostics	5	6.0
<i>App₁₀</i>	Virtual reality and computer network	3	3.6
<i>App₁₁</i>	Design and building construction	3	3.6
<i>App₁₂</i>	Wear and tear monitoring	2	2.4
<i>App₁₃</i>	Lithography hotspot detection	1	1.2

Sample Synthesis Table

	Study	Research Focus	Methodology	Key Findings	Gaps Identified
1	Study 1	AI in Student Learning	Case Study	AI improves student engagement	Limited real-world case studies
2	Study 2	AI in Teacher Support	Survey Analysis	Teachers benefit from AI-based feedback	Need for more teacher training on AI
3	Study 3	AI in Assessments	Experimental Study	Automated grading enhances efficiency but raises fairness concerns	Ethical concerns in automated grading

2. Meta-Analysis (For Quantitative Synthesis)

Best for: Aggregating numerical data from multiple studies to measure overall effects.

Steps:

1. **Extract numerical data** (e.g., effect sizes, means, standard deviations).
2. **Use statistical tools** (e.g., forest plots, confidence intervals) to compare study outcomes.
3. **Assess heterogeneity** – Check variability among studies to ensure comparability.
4. **Interpret combined results** to determine AI's impact in education.



Example Application:

- Measuring **student performance improvements** across multiple studies using **AI-driven tutoring systems**.

3. Coding Framework (For Qualitative & Mixed Methods Synthesis)

Best for: Structuring findings based on predefined categories (e.g., AI applications, challenges, future directions).

Steps:

1. **Develop a coding scheme** based on research objectives.
2. **Assign codes** to extracted study data (e.g., "AI impact on learning outcomes").
3. **Analyze patterns** across studies.
4. **Summarize key insights** with direct references to studies.

📌 **Example Codes for AI in Education:**

- **AI in Adaptive Learning** → Personalized recommendations, dynamic curricula.
- **AI in Student Assessment** → Automated grading, bias concerns.
- **Challenges in AI Adoption** → Infrastructure issues, teacher training gaps.

Interpretation and Discussion

1

Interpret the findings and their implications in relation to the research question.

2

Discuss the strengths and limitations of the included studies.

3

Compare and contrast the results, methodologies, and conclusions of the selected studies.

Draw Conclusions

1. Summarize the key findings of the systematic literature review.
1. Address the research question or objective based on the synthesized evidence.
1. Identify any recommendations, implications for practice or policy, and future research directions.



Addressing Common Challenges in SLR



Defining

Defining a research scope that's too broad or too narrow

Managing

Managing large numbers of articles effectively

Avoiding

Avoiding bias in study selection

Key Takeaways & Best Practices for Conducting a Systematic Literature Review (SLR)



Key Takeaways

- ✓ SLRs ensure transparency, reproducibility, and rigor in research synthesis.
- ✓ Formulating a clear research question (using PICO/SPIDER) is essential for a well-structured review.
- ✓ A systematic search strategy using Boolean operators, truncation, and synonyms helps retrieve relevant studies.
- ✓ PRISMA framework provides a structured approach to screening and selecting high-quality studies.
- ✓ Quality assessment tools (Cochrane RoB, CASP, AMSTAR, NOS) help filter out weak or biased studies.
- ✓ Data extraction and synthesis techniques (Thematic Analysis, Meta-Analysis, Coding Frameworks) ensure meaningful conclusions.
- ✓ Addressing biases, limitations, and gaps strengthens the reliability of the review.



Best Practices

- ◆ **Define Clear Inclusion & Exclusion Criteria** – Ensure studies meet the research scope and methodological standards.
- ◆ **Use Multiple Databases** – Search in **Scopus, Web of Science, IEEE Xplore, Google Scholar** for comprehensive coverage.
- ◆ **Document Every Step** – Maintain **search logs, PRISMA records, and quality assessment checklists** for reproducibility.
- ◆ **Visualize Findings** – Use **PRISMA diagrams, synthesis tables, and thematic maps** to present data effectively.
- ◆ **Critically Analyze Studies** – Go beyond summarizing; **identify trends, challenges, and research gaps**.
- ◆ **Ensure Consistency & Objectivity** – Apply **consistent criteria and avoid selective bias** in study selection.
- ◆ **Follow Reporting Guidelines** – Use **PRISMA for systematic reviews** and adhere to journal/conference standards.



Final Tip: SLR is an iterative process! Refine your research scope, update searches, and validate findings for a **robust and impactful review**.

Q & A



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