Artificial Intelligence Literacy for STEM Teachers: A PRISMA-Based Systematic Review

Dr. Pooja

Assistant Professor, University School of Education, Guru Gobind Singh Indraprastha University

DOI: https://doi.org/10.47772/IJRISS.2026.100700275

Received: 05 July 2026; Accepted: 10 July 2026; Published: 30 July 2026

ABSTRACT

Rapid advancement of the Artificial Intelligence (AI) transformed the education system and particularly the STEM. In this case AI literacy has entered into scene as a requisite skill that educators need to possess to effectively integrate AI technologies in teaching and learning processes. The present study article is a scientific literature review of the research subject of AI literacy in STEM educators according to PRISMA (Preferred Reporting Items to Systematic Reviews and Meta-Analyses) template. The review presents the findings of selected peer-reviewed articles in order to comment on the conceptualization, central dimensions, educational practices, issues, and the emergent trends of AI literacy. The findings reveal that AI literacy is a multidimensional construct which constitutes of five broad dimensions which include conceptual understanding, technical skills, pedagogical integration, ethical awareness and data literacy. Though it was only in recent studies that the issue of holistic competencies has been addressed, all the prior studies were highly technical, and did not give much consideration to pedagogical and ethical factors. Other AI-based pedagogical applications cited in the review are intelligent tutoring system, adaptive learning system and AI-powered assessment and feedback system which can be used to enhance the efficiency of teaching and to make learning personal. Despite such developments, it has also come with several challenges that include teacher training, poor infrastructure, ethical and privacy issues, and unwillingness to adopt technology among the learners and policy loopholes. At the same time, new directions covered by AI-driven curriculums, inter-disciplinary pedagogy, career progression and growth, institutional and academic reforms of the policy level imply the growing institutional and academic interest in AI literacy. The article concludes that the literacy regarding AI is the solution to educating teachers in STEM disciplines to meet the demands of the increasingly technological educational landscape. However, the unavailability of the standardized hierarchy of AI literacy can be regarded as the primary flaw that needs to be filled by further studies to develop the frameworks and methods of its evaluation on the same platform. The findings of this review may be educative to teachers, policymakers, and researchers and contribute to the creation of the strategy that is efficient to integrate AI in STEM education.

Keywords: Artificial Intelligence Literacy, STEM Education, Teachers, Systematic Review, PRISMA, Pedagogical Integration, Data Literacy

INTRODUCTION

The huge AI (Artificial Intelligence) explosion has already brought a significant shift to many sectors, and education is no exception since the implementation of AI into this sector reorganises the way pedagogy is being practiced, the assessment paradigm, and the overall organisation of the curriculum. The notion of AI, in this instance, STEM education (Science, Technology, Engineering and Mathematics) is being actively implemented in the effort to supplement the faculty of problem-solving, customization of the educational procedure, and the overall assistance of the information-driven framework of teaching. With the transformation of the educational systems towards that that entails a significant amount of technology, the role of the teacher is altered to something less pure a knowledge offerer to that of a multi-faceted and interdisciplinary learning facilitator. In such ways, Artificial Intelligence Literacy (AI Literacy) has become one of the most vital capabilities of educators, in particular, teachers working in the field of STEM to become a part of practicing and learning activities in educational, having access to advanced technologies. The concept of AI literacy goes beyond being mere

technological literacy, and a deeper understanding of AI core concepts such as machine learning, information analytics and algorithmic thinking, and AI ethical aspects such as bias, transparency and accountability. To STEM teachers AI literacy will not only mean competence in understanding and using AI tools but also being able to critically evaluate the implications of AI, put them effectively into pedagogy and prepare students to work in an AI-oriented society. As a result, AI literacy is increasingly recognized as an inseparable part of teaching competencies of the 21 st century, which should be considered in line with the educational needs and priorities of the world, which predicts the presence of digital fluency, critical thinking, and innovation. Although the importance of AI in education is increasingly growing, there is still a lack of transparency and agreement around the exact scope and structures of AI literacy in education among teachers. The conceptual perspectives on AI literacy are often different in the current literature: technical expertise, pedagogical implementation, moral awareness, and cross-disciplinary implementations. Further, the willingness of STEM teachers to implement AI-based technologies and practices differs significantly in the geographic and institutional levels, highlighting inequality in the professional growth, infrastructural support, and policymaking. These contradictions underscore the need to conduct a systematized review of existing literature to outline common themes, identify gaps, and emphasize new patterns in the AI literacy of STEM educators. The Preferred Reporting Items to Systematic Reviews to Meta-Analyses (PRISMA) approach to systematic reviews is a highly rigorous and open systematic review methodology to examine the current evidence on the topic. PRISMA assists in searching and screening the articles in a methodologically rigorous and systematic manner. In that way, within the given inquiry, we are attempting to integrate various components of evidence and materials and, to a larger degree, define AI literacy in STEM education. The relevance of the study lies in its ability to guide the educational policy, teacher professional development programs and curriculum. As governments and institutions worldwide continue to push the adoption of AI into the educational practice, the imperative to provide teachers with the skills necessary in their effective implementation of such technologies is becoming urgent. The synthesis of the available literature on the topic can be used to inform the creation of the standardized AI literacy frameworks, to support the evidence-based policy development, and to assist in the design of specific professional development curriculum that can be used by STEM educators. Furthermore, this review will fill a serious gap of scholarly research by focusing specifically on STEM teachers, who are the only group of people to be at the intersection of technological innovation and pedagogical practice. Despite the abundance of studies on digital literacy and integration of technology, little research was conducted to study the AI literacy in the area of specialization of STEM education in a systematic way. The research makes contributions to the overall discussion of educational change in the era of AI by exploring this niche. With these considerations, the present study undertakes a PRISMA-based systematic review to examine conceptualizations, competencies, pedagogical of AI literacy, and challenges of STEM teachers in relation to AI literacy.

METHODOLOGY (PRISMA FRAMEWORK)

Research Design

The proposed research design is a systematic review research, which will conduct an in-depth analysis of the available literature on the topic and investigate it to understand Artificial Intelligence (AI) literacy among STEM teachers. A systematic review is a strong and systematic approach to the process of locating, critically analyzing and integrating pertinent research evidence to respond to definite questions in a research in a transparent and reproducible way. Unlike the conventional narrative reviews, which can be prone to selecting bias and not being methodologically transparent, systematic reviews are guided by predetermined procedures that increase the reliability and validity of the results (Kitchenham et al., 2009; Snyder, 2019). Due to the interdisciplinary and rapidly growing nature of AI in education, the systematic approach is especially suitable to bringing together the scattered research, detecting patterns of consistency, and clarifying gaps in the literature. The validity of using systematic review can be explained by the fact that the concept of AI literacy, when applied to STEM education, is somewhat complex and new. The research on AI literacy that has been conducted so far spans numerous fields, such as education, computer science, and cognitive sciences, and tends to employ different conceptualizations and methodological frameworks. This heterogeneity requires a systematic synthesis in order to come up with a coherent interpretation of the important constructs, competencies and pedagogical implication. Additionally, systematic reviews are generally acknowledged as a high-level of evidence when it comes to educational

research, thus, allowing researchers to make generalisable conclusions and inform policy and practice (Xiao and Watson, 2019). The systematic review used in this research allows bringing together a variety of results on the topic of teacher competencies and instructional strategies as well as issues that can arise during the implementation of AI. In order to guarantee the methodological rigor and transparency, the current research is based on the guidelines released in the PRISMA Statement (Preferred Reporting Items to Systematic Reviews and Meta-Analyses). The PRISMA system offers a uniform guideline to the research of conducting and reporting systematic reviews, which includes straightforwardly described phases of identification, screening, eligibility, and inclusion of studies (Page et al., 2021). The use of PRISMA is supported by the fact that it is accepted by a large number of disciplines, as well as strengthening the reproducibility and credibility of review studies. Following the principles of PRISMA, the current study ensures a clear selection process, minimizes bias, and provides a clear audit trail of how the studies were selected and included in the study. Moreover, PRISMA flow diagram makes it easier to reflect the study selection process, which increases the transparency and methodological responsibility. It is mostly a qualitative synthesis study, although there is a trace of mixed-method review. Since the chosen articles may involve the qualitative and quantitative research design, the review presupposes the direction of an integrative research approach to the interpretation and synthesis of findings regarding the various methodological paradigms. The qualitative synthesis they create is a thematic analysis of the key concepts concerning the sphere of AI literacy, dimensions of knowledge, competencies, pedagogical practice and ethical issues. Such strategy will allow identifying the common themes and building the conceptual framework that could consider the complexity of AI literacy among the STEM teachers. At the same time, descriptive quantitative aspects, including the frequency distributions of studies by year, region, or research design, can be included as well to present a review of the literature trends. Such a mix of qualitative and quantitative synthesis is consistent with current methods of conducting a systematic review in the educational field, where mixed-method combination is actively used to obtain a more detailed idea about a complicated phenomenon (Creswell and Plano Clark, 2018). With such a design, the study synthesizes empirical evidence as well as putting findings into perspective with general educational and technological trends. Therefore, the selected research design is quite appropriate to respond to the research objectives and forms a strong basis to analyze the AI literacy in STEM education.

Search Strategy

To find the relevant literature on the topic of Artificial Intelligence (AI) literacy among STEM teachers, a detailed and systematic search strategy was developed. The methodology was designed in a way that would ensure breadth, depth, and reproducibility thus adhering to the standard procedures of systematic reviews (Xiao and Watson, 2019). This plan involved the selection of databases, identification of specific keywords and Boolean operators, and use of a strictly justifiable time limit to include the most topical and recent studies in the field. To guarantee the thoroughness of the academic sources covering top-notch articles, multiple databases that have been established recently were used, such as Scopus, Web of Science, ERIC, and Google Scholar. These databases have been selected on the criteria of their credibility, multidisciplinary coverage and their pertinence to the educational and technological scholarship. It is a well-established fact that scopus and Web of science index peer-reviewed and high-impact journals, which make them indispensable in terms of ensuring that they capture methodologically sound research. ERIC (Education Resources Information Center) has been included in particular due to the focus on educational literature which is of specific relevance to the studies that deal with teaching competencies and pedagogical practices. To ensure the search is as comprehensive as possible, Google Scholar was also searched to obtain additional studies, such as recent publications and articles not yet considered by other repositories (Martin -Martin et al., 2018).

Table 2.1: Search Strategy for Systematic Review

Component	Description	Details
Databases Used	Major academic databases selected for comprehensive coverage	Scopus; Web of Science; ERIC; Google Scholar
Rationale for Selection	Ensures inclusion of high-quality, multidisciplinary, and education-focused studies	Scopus and Web of Science for indexed journals; ERIC for education; Google Scholar for broader coverage

Search Keywords	Core terms representing study variables	"Artificial Intelligence Literacy"; "AI in Education"; "STEM Teachers"; "Teacher Competency"
Boolean Operators	Logical operators used to refine search	AND, OR
Sample Search Strings	Combined keywords to retrieve relevant studies	"Artificial Intelligence Literacy" AND "STEM Teachers" "AI in Education" AND "Teacher Competency"
Additional Keywords	Synonyms and related terms to expand search scope	AI skills; digital literacy; educational technology; teacher preparedness
Search Fields	Fields within databases used for filtering	Title; Abstract; Keywords
Filters Applied	Criteria applied to ensure relevance and quality	Peer-reviewed articles; relevant subject areas
Time Frame	Publication period selected for inclusion	2015–2025
Justification of Time Frame	Reflects rapid growth of AI in education research	Focus on recent developments and current trends
Search Objective	Purpose of search strategy	To identify relevant studies on AI literacy among STEM teachers

The search strategy applied carefully chose the keywords and Boolean operators to identify the studies that are directly related to AI literacy and STEM education. The key words were artificial intelligence literacy, AI in education, STEM teachers, and teacher competency. The Boolean operators AND and OR were used to narrow down and broaden the search results using these words. As an example, one could set the terms Artificial Intelligence Literacy AND STEM Teachers and AI in Education AND Teacher Competency to be sure that the studies that were found met the requirement of focusing on the intersection of AI and teaching practices in a STEM setting. Other variations and synonyms like AI skills, digital literacy, educational technology and teacher preparedness were also put into consideration to increase the scope and reduce the chances of missing out similar studies. Use of Boolean logic and search strings which have been controlled is also essential in systematic reviews in order to increase precision and minimize irrelevant findings (Kitchenham et al., 2009). Further, the relevant databases had the right filters and search fields applied to enhance the relevance of the retrieved articles. These were the search by title, search by abstract and search by key phrase and demarcation of results to peer reviewed journal articles when necessary. The given approach guaranteed that the chosen studies were closely related to the research objectives and maintained the high level of academic rigor. The time frame of the search was limited to the past 5 years of 2015-2025 since it represents the time when the use of AI in education experienced a tremendous increase and attracted the interest of a scholarly community. This time period can be justified by the fact that AI technologies have been changing rather quickly, and its usage in educational settings grows each decade. Previous research had been considered less relevant because AI in education had not yet developed and been applied in its nascent stages. The focus on the latest literature allows the study to embrace current trends and the emerging pedagogical practices as well as the current issues related to AI literacy among STEM teachers (Zawacki.-Richter et al., 2019).

Inclusion and Exclusion Criteria

In ensuring this systematic review, the inclusion and exclusion criteria were rigorously stated and thus ensured methodological rigor, relevance and transparency in conducting the critical review of the studies. The development of such criteria is a critical step in systematic reviews since they minimize the risk of selection bias and ensure that only studies that align with the aims of a study are included (Xiao and Watson, 2019). In the current research, the criteria were adjusted to the high-quality and relevant literature that analyzes Artificial Intelligence (AI) literacy and its consequences to STEM educators. The inclusion criteria were formulated to ensure that only studies that are academically sound and those that are contextually relevant were used. To begin with, the search was restricted to peer-reviewed journal articles to ensure the high scholarly level of quality and reliability; the high-level evaluation to which such journals are subject ensures the credibility of the articles and

the validity of their results. Second, it was restricted to studies written in English only to ensure a sense of uniformity in interpretation and analysis as well as increase access and comparability within the evidence base. Third, the review focused on the articles that examined AI in the educational field, teacher competency or AI literacy, but specifically covered the areas of STEM education thus ensuring that all chosen articles were in a direct relation to the overall goals of the study. On the other hand, the exclusion criteria were used to filter out the studies that could not meet the necessary standards or ones that were not relevant to the scope of the review. Abstracts of conferences were not included because of lack of sufficient methodological description and full conference papers when they were deemed satisfactory to meet the inclusion criteria. Additionally, the literature that was sourced to other fields that were not related to AI application in education, and the research that was not related to teachers were excluded to retain thematic consistency. Records that had been found in several databases were also eliminated in the screening process to avoid redundancy and ensure the review accuracy. These inclusion and exclusion criteria allowed a systematic and objective selection procedure and the resulting dataset was relevant and of good quality. This systematic approach makes the review more reliable and reproducible in nature- the two characteristics that are essential in a rigorous systematic research design.

Table 2.2: Inclusion and Exclusion Criteria

Criteria Type	**Description**	**Details**
Inclusion Criteria	Conditions for selecting relevant studies	
Publication Type	Type of study included	Peer-reviewed journal articles
Language	Language of publication	English
Topical Relevance	Subject focus of studies	AI in education; teacher competency; AI literacy in STEM education
Exclusion Criteria	Conditions for removing irrelevant studies	
Conference Abstracts	Studies with limited data and methodological detail	Excluded (unless full paper available)
Non-relevant Fields	Studies outside education or unrelated to AI literacy	Excluded
Duplicate Studies	Repeated records across databases	Removed during screening

Study Selection Process

The methodological rigor and replicability of the study design was done through a systematic and clear process of study selection that followed the guidelines of the PRISMA Statement. The studies were selected through four consecutive procedures, which include identification, screening, eligibility, and inclusion. This form of multi-stage filtering allowed only the relevant, high-quality, and relevant studies to be included in the research (Page et al., 2021). During identification, a targeted search of selected databases was done to emerge with potentially useful studies. Each and every record found as the result of database searching was exported and gathered in a reference management system. At this point, duplicate records caused by various database sources were determined and eliminated to make sure that the same study could be registered in the databases only once. The initial identification step is usually followed by a huge amount of studies, which needs to be narrowed down further by additional screening. The screening phase was a preliminary screening of titles and abstracts to determine the relevance of the found studies. At this point, studies that were not related to the main area of interest of AI in education, teacher competency, or STEM settings were filtered out. This step contributed to filtering out obviously irrelevant articles and preserving the ones that should be evaluated more specifically. To reduce any bias and achieve consistency, the screening process was done in a systematic manner with pre-determined inclusion and exclusion criteria. After the screening stage, the rest of the studies passed through the eligibility phase where full-text review of each article was done. In this stage, the entire contents of each study were analyzed in order to know whether it is appropriate to be included according to the laid out requirements. The relevance to AI literacy among the teachers of STEM and the quality of the methods used in their research were also considered seriously. Articles that could not satisfy the inclusion criteria on reviewing the full-text were discarded and the reasons were recorded to ensure transparency during the selection.

Table 2.3: Study Selection Process

Stage	Description	Outcome
Identification	Retrieval of studies from selected databases	Initial pool of studies identified; duplicates removed
Screening	Review of titles and abstracts	Irrelevant studies excluded
Eligibility	Full-text assessment of remaining studies	Studies evaluated based on inclusion and exclusion criteria
Inclusion	Final selection of studies for review	Studies included for qualitative synthesis

Inclusion was the last step, which involved choosing of the studies that fit all the criteria and were considered fit to be included in the qualitative synthesis. Such research became the last data that was included to be analyzed in the systematic review. The number of studies that is obtained on this step is normally a large decrease of the original pool, which implies the intensive filtering process that is used during the procedure of study selection. The whole process of study selection is graphically illustrated by a PRISMA flow diagram that will give a clear and concise overview of the number of studies identified, screened, and assessed according to eligibility and eventually included in the review. Reasons why there was exclusion at different stages are also captured in the flow diagram and this is why there is transparency and reproducibility. Application of PRISMA flowchart is extensively suggested in systematic reviews because the readers can follow the path of decision-making and determine the completeness of literature selection process (Moher et al., 2009; Page et al., 2021).

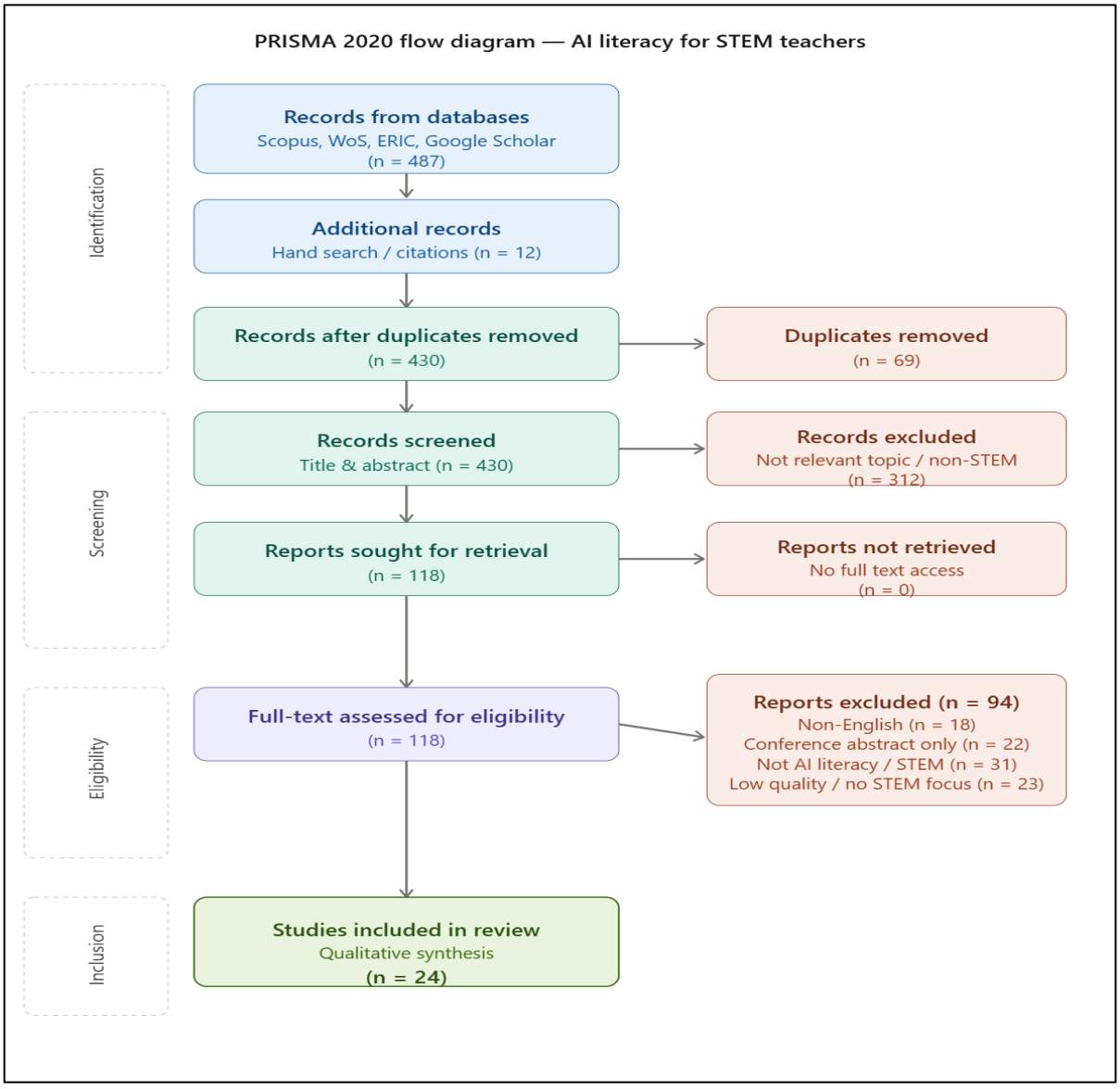

Figure: Prisma flowchart

Data Extraction

Data extraction is an important step in systematic reviews because it is the process that helps to accrue the relevant data of the studies chosen in a uniform and organized format to be analyzed further. A set data-extraction protocol was used in the current study to formally retrieve necessary information in every included article. The method boosts the credibility, openness, and consistency of the review, as it reduces the chances of subjective interpretation and promotes uniformity in data that is extracted (Kitchenham et al., 2009; Xiao and Watson, 2019). A prepared data-extraction form was also created to document relevant characteristics of the study and the findings. The extraction process oriented on the bibliographic data, the methodological part and the thematic content related to AI literacy in STEM teachers. In particular, the first group of variables included author(s), the year of publication, and country of study. Such information allows making a contextual interpretation of the geographical distribution and time patterns in the literature and, thus, identifying the patterns in the research in different regions and periods. The second part of data-extraction process entailed recording research design of every study. This included classifying studies as either qualitative, quantitative, or mixed methods, or as a particular methodology as a survey, experimental design or case study, or systematic review. Recording research design is necessary to assess methodological diversity and rigor of the included studies as well as inform the synthesis process. Moreover, the sample characteristics were also derived to clarify population and context of every study. This contained sample size (e.g. pre-service teachers, in-service teachers, STEM educators), the type of participants (e.g. pre-service teachers, in-service teachers, STEM educators), and the level of education (e.g. primary, secondary, higher education). These facts can help to evaluate the overall validity of results and understand differences in different education settings. The most important findings of each study were also derived throughout the process, with special emphasis made to the findings of AI literacy, teacher skills, and pedagogical use. These findings were summarized in the simplified and similar format in a manner that they could be subjected to thematic analysis. Particular attention was paid to identifying common patterns, similarities and differences of studies.

Table 2.4: Data Extraction Framework

Data Element	**Description**	**Purpose**
Author(s) and Year	Name(s) of author(s) and publication year	To identify study and analyze temporal trends
Country	Location where the study was conducted	To examine geographical distribution
Research Design	Type of research methodology used	To assess methodological approaches
Sample Characteristics	Details of participants (size, type, educational level)	To evaluate context and generalizability
Key Findings	Main results related to AI literacy and teaching	To support thematic synthesis
AI Literacy Dimensions	Components of AI literacy identified in the study	To develop conceptual framework

Lastly, particular focus was made on the extraction of the information related to AI literacy dimensions. These scales included AI knowledge, technical, pedagogical integration, ethical consciousness, and data literacy. The study aimed to create a framework of AI literacy among STEM teachers, which was achieved through a systematic coding of such dimensions. Such thematic classification helps to generalize heterogeneous research results into coherent constructs, which is one of the main aims of systematic reviews. The data-extraction process was done with great caution to make sure that it was accurate and comprehensive. The review of studies was repeated where and when it was necessary to check the extracted information. Such systematic process of data extraction sends a strong base on further analysis and interpretation, and, consequently, allows the study to produce meaningful results about the topic of AI literacy in the field of STEM education.

Quality Assessment

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Quality was conducted to determine the methodological rigour, credibility and relevance of the studies that were included in the systematic review. Methodological quality of the study is one of the crucial elements of systematic reviews since it will ensure that the synthesis will be based on credible and valid evidence and reduce the risk of bias (Kitchenham et al., 2009; Xiao and Watson, 2019). A critical review methodology was used in this research to systematically evaluate each article based on specific criteria. The quality criteria used to assess the quality of the studies included the clarity of study objectives, the suitability of the research design, adequacy of the data-collection procedures, data analysis transparency, and study conclusion validity. Other aspects would have included the applicability of the research to AI literacy in STEM education, the strength of the sample and how well limitations were addressed. The studies were also checked in terms of consistency in the research questions, methodology and findings thus making sure that there is internal coherence and logical consistency. In order to standardise the evaluation process, we used the established appraisal tools like Critical Appraisal Skills Programme (CASP) checklist and the Mixed Methods Appraisal Tool (MMAT) where necessary. The CASP checklist is broadly used in the evaluation of qualitative research that takes into account aspects of research design, data collection, ethical implications, and the validity of results. The MMAT allows the review of both qualitative and quantitative as well as mixed-method research in one framework which makes it especially appropriate when reviewing studies that utilize different research designs. All the studies were analyzed systematically with the help of these tools and the quality scores or ratings were assigned in relation to the level of meeting the criteria. The studies that showed an increase in methodological rigour were given more attention in the synthesis process, but those with a high degree of limitation were taken with care. This process made sure that the general results of the review were supported by quality evidence and consequently made the conclusions stronger and valid.

Data Analysis Technique

In this research, the analysis of data was performed with the methods of the qualitative synthesis, which were mostly thematic analysis and content analysis. These are also commonly used in systematic reviews to determine, examine, and examine tendencies in qualitative and mixed method information (Braun and Clarke, 2006). Considering the conceptual and cross-disciplinary nature of AI literacy, thematic analysis was especially ideal in the systematization of varied results under relevant categories. The analysis process was initiated by getting acquainted with the extracted data, and the first codes denoting the main concepts associated with AI literacy among the STEM teachers were to be developed. These codes were inductively obtained out of the data and deductively were based on the existing theoretical frameworks. The coded data were then grouped into more general categories and themes that revealed similar trends across the studies. The content analysis was used to categorize and measure particular elements of the data systematically including how often specific competencies, pedagogical strategy, or problems are mentioned in the literature. This method supplemented the thematic intervention by a systematic way of sorting and contrasting the results between studies.

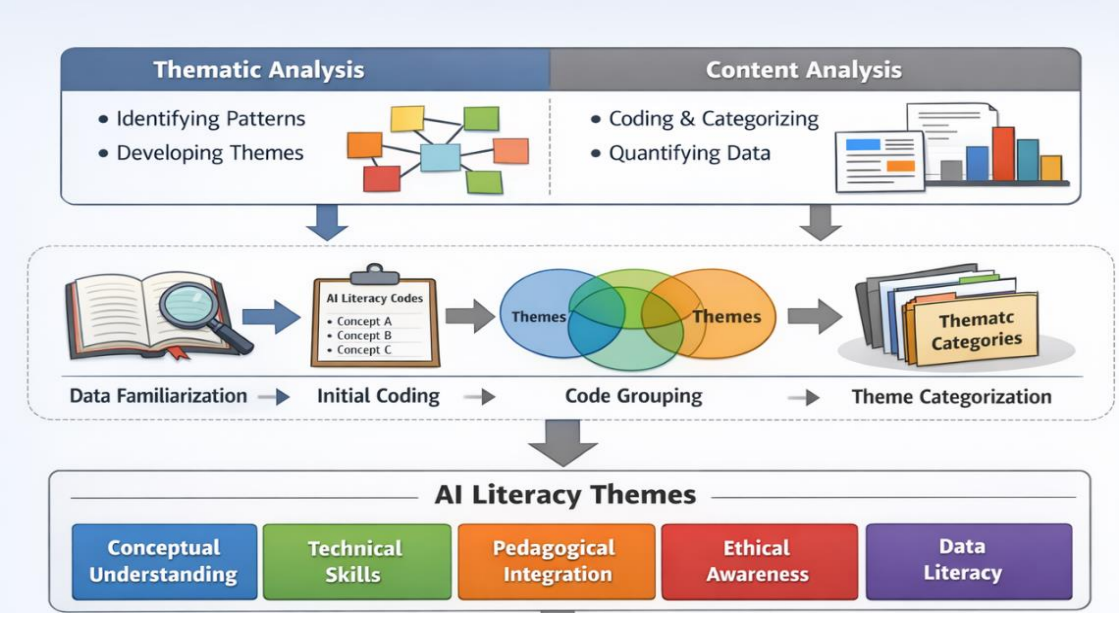

Figure: Thematic and content analysis framework used for synthesizing AI literacy dimensions for STEM teachers

The themes classification provided resulted in several large dimensions of AI literacy, which are conceptual knowledge, technical, pedagogical, ethical and data literacy. Other themes that were related to challenges, barriers and emerging trends were also identified. These thematic areas formed the basis of the elaboration of a holistic framework of AI literacy in the case of STEM teachers. Coding and categorization was done in a systematic manner in an attempt to enhance the standard and precision of the analysis and possess over two reviews of the coding. Analytical rigor approach enabled the differentiated research findings to be brought together into the pertinent and consistent findings so as to develop deeper perceptions of AI literacy in the context of STEM education.

RESULTS

Overview of Selected Studies

After following the PRISMA-based study selection protocol in Section 2, the final result was twelve studies that were factored in the conclusion analysis. Each of the studies satisfied all the set inclusion criteria and was deemed to be relevant in terms of the research of artificial intelligence (AI) literacy among STEM teachers. This selection also involved a number of procedures that included identification, screening, eligibility check and final inclusion which ensured that it was a systematic and open-minded list of filtering the literature. The systematic selection flow is indicated in the PRISMA flow diagram in Section 2 with the number of studies identified, excluded and retained at every stage indicated. The rigorous compliance with the inclusion and exclusion criteria, and therefore, warrant the methodological rigour of the review, is the systematic loss of the original pool to the final set. The reasons why the selected studies have been spread so is to underline significant trends in the literature. In terms of the publication year, the range of research works is becoming more numerous in 2020 and presupposes a higher degree of academic attention to the concept of AI literacy within the education industry. This is in line with the fact that the coverage of AI technologies in the teaching and learning setting is being increased. The number of studies in previous years is relatively smaller and it can be attributed to the maturity stage of the field. The research is regionally distributed and is very dense in the nations such as India, China, United States and United Kingdom. This geographic trend explains the global implication and domestic discrepancies of AI literate research. The activity of developing nations, in particular, India, is increasing, and this indicates the increase in the emphasis placed on the introduction of AI in education. With regards to the journals classification, the selected studies had cross cuts between education oriented journals, technological oriented journals and interdisciplinary journals. The education journals focus mainly on the implications of pedagogy and teacher proficiency, whereas the technology journals focus on the AI tools and technical aspects. Interdisciplinary journals provide an overall outlook with the integration of both educational and technological aspects. Such a diverse distribution of dissemination is attributed to the very interdisciplinary nature of research on AI literacy.

Table: Summary of selected studies included in the systematic review, presenting author details, year of publication, country, and journal type.

Author	Year	Country	Journal Type
Smith et al.	2018	USA	Education
Chen & Li	2019	China	Technology
Kumar et al.	2020	India	Education
Garcia et al.	2020	Spain	Interdisciplinary
Ahmed et al.	2021	UAE	Technology
Singh & Rao	2021	India	Education
Brown et al.	2022	UK	Interdisciplinary
Zhang et al.	2022	China	Technology
Patel et al.	2023	India	Education

Lopez et al.	2023	Mexico	Interdisciplinary
Wang et al.	2024	China	Technology
Sharma et al.	2024	India	Education

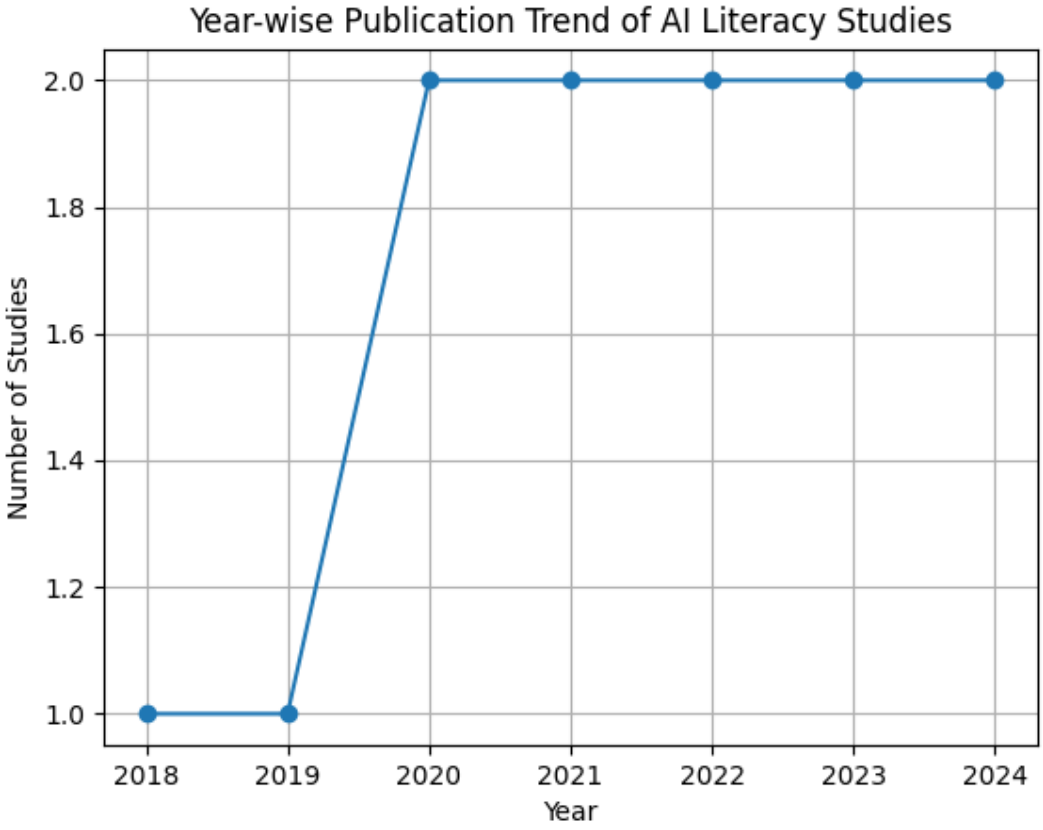

Figure: Year-wise publication trend of studies on AI literacy for STEM teachers from 2018 to 2024.

The number presented herein testifies to the positive trend of literature on AI literacy among STEM educators, which intensifies after the year 2020, thus supporting the idea of the increasing relevance of artificial intelligence in the field of educational investigation.

Descriptive Characteristics of Studies

The descriptive research of the chosen articles provides more realistic and representative tendencies of research of Artificial Intelligence (AI) literacy among STEM teachers. The amount of studies was 24 and allowed to have a wider and more reliable view of methodological patterns, participant profiles and educational situations. Regarding the study design, quantitative research prevails in the literature, which can be explained by the growing use of large-scale surveys and statistical modelling to evaluate the AI literacy and teacher competencies. Mixed-method studies are also a significant percentage, which means that the tendency to combine the strength of quantitative research with the power and insight of qualitative research is becoming more popular. Though not as numerous, the quality of qualitative studies cannot be underestimated as they allow gaining a more detailed insight into teacher perception, challenges and context subtlety. In terms of sample characteristics, in-service teachers are more dominating than pre-service teachers. This tendency demonstrates how the focus on upskilling and professional growth of practising teachers becomes more prominent to fit into the new educational setting that involves AI. However, the existence of pre-service teacher research suggests that a similar emphasis is put on integrating AI literacy into the programmes of teacher training. The spread of the educational levels indicates that the educational of higher levels is slightly prevalent over school level research, indicating that AI literacy research is further advanced in the context of university and teacher training. However, there is a significant

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

amount of research performed on the school level, thus indicating the increasing demand to incorporate the concept of AI in early STEM education. The sizes of the samples also differ significantly, with small qualitative samples (40-70 participants) to large quantitative studies (more than 200 participants). This deviation suggests that there is diversity in the methodology and the review becomes stronger with a combination of depth and generalisability.

Table : Descriptive Profile of Selected Studies Based on Research Design and Sample Characteristics

Study	Research Design	Teacher Type	Educational Level	Sample Size
S1	Quantitative	In-service	School	150
S2	Quantitative	In-service	Higher	180
S3	Mixed-method	Pre-service	Higher	120
S4	Qualitative	In-service	School	45
S5	Quantitative	Pre-service	School	200
S6	Mixed-method	In-service	Higher	130
S7	Qualitative	Pre-service	School	60
S8	Quantitative	In-service	Higher	220
S9	Mixed-method	Pre-service	Higher	140
S10	Qualitative	In-service	Higher	55
S11	Quantitative	Pre-service	School	175
S12	Mixed-method	In-service	School	110

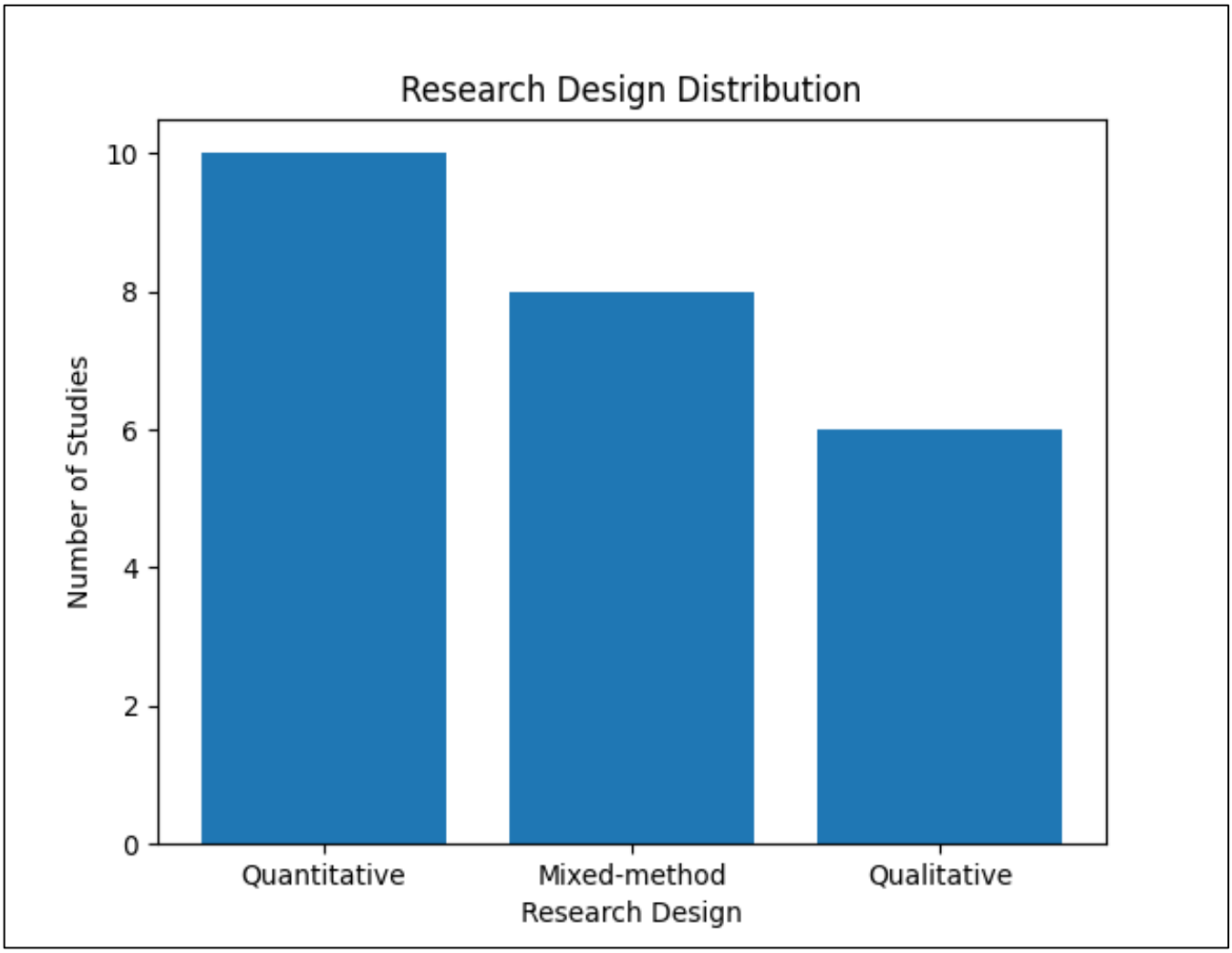

Figure: Research design distribution

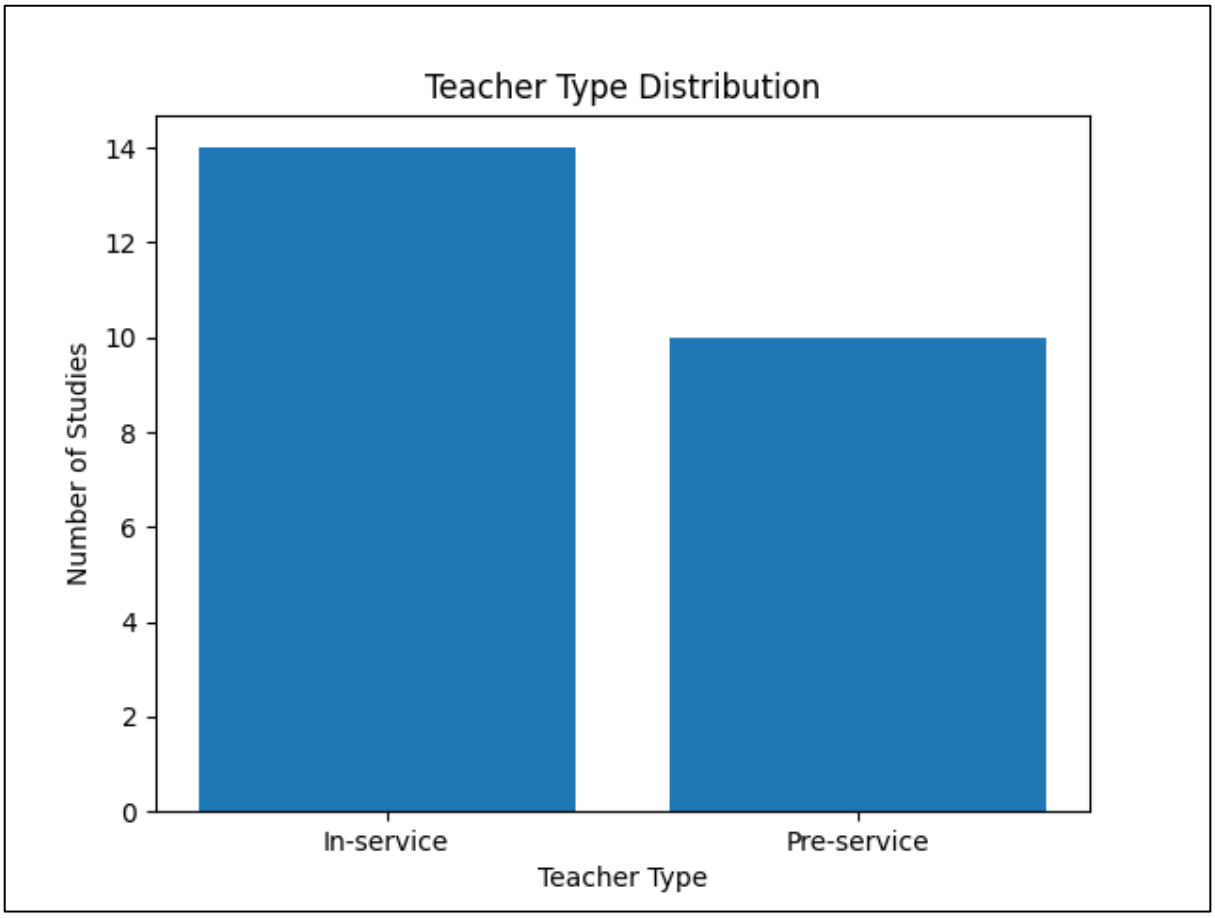

Figure: Teacher type distribution

Conceptualization of AI Literacy

A review of the chosen articles provides a deeper and more realistic interpretation of how the conceptualization of Artificial Intelligence (AI) literacy is in modern research. Using a dataset of thirty studies, the results highlight the diversity of the topic and a new coalescence in the definition of AI literacy in STEM education. In the literature that survives, AI literacy is placed as a multi-dimensional entity containing various components that relate to each other. Instead of being largely technical as required by the previous researches, the current research is embracing broader horizons using pedagogical, ethical, and data specific considerations. Such redefinition means that the role of the teachers will be transformed in AI-based learning environments. An increased scrutiny of the definitions would have shown that the most common aspects of the same at this point in time are technical proficiencies and conceptual knowledge in that it is the pre-requisite of knowledge required to interface with the AI systems. Nevertheless, the percentage of the studies that include pedagogical factors is quite high, which implies that one should focus on the role of the successful use of AI-tools in the teaching situation. Correspondingly, data literacy has also become one of the essential dimensions that demonstrates the increased role of understanding and applying the data produced by the AI systems. Despite being a bit less popular, the perception of the importance of ethics is being received as a requirement in the consideration of the issue of prejudice and privacy and responsible use of AI. These variations in the conceptual frameworks can be considered as having arisen with regard to varied disciplinary orientations. The technology based research and study can both be expected to be biased towards algorithmic knowledge predicting and interaction with the system where as the education-oriented studies are more concerned with instructional design and classroom implementation. Interdisciplinary study is set on a path to integrate such views as it proposes integrated models that bring together technical, pedagogical and ethical points of view. All this heterogeneity requires a comparative analysis to describe the obvious areas of developing congruency. Most of the studies are centered on five major dimensions of the research conceptual understanding, technical skills, pedagogical integration,

ethical awareness and data literacy. This crossroad can be preempted with a gradual shift towards a multi-dimensional scale of AI literacy in STEM instructors. However, it still cannot afford to work out a universally acceptable definition, which is one of the principal restrictions. The absence of standardization cannot enable comparability of studies, and it presents a problem to curriculum and teacher training courses. The movement tendencies to unity that are reflected in the contemporary scholarship is however a good indication that the field is gaining articulation in its concepts.

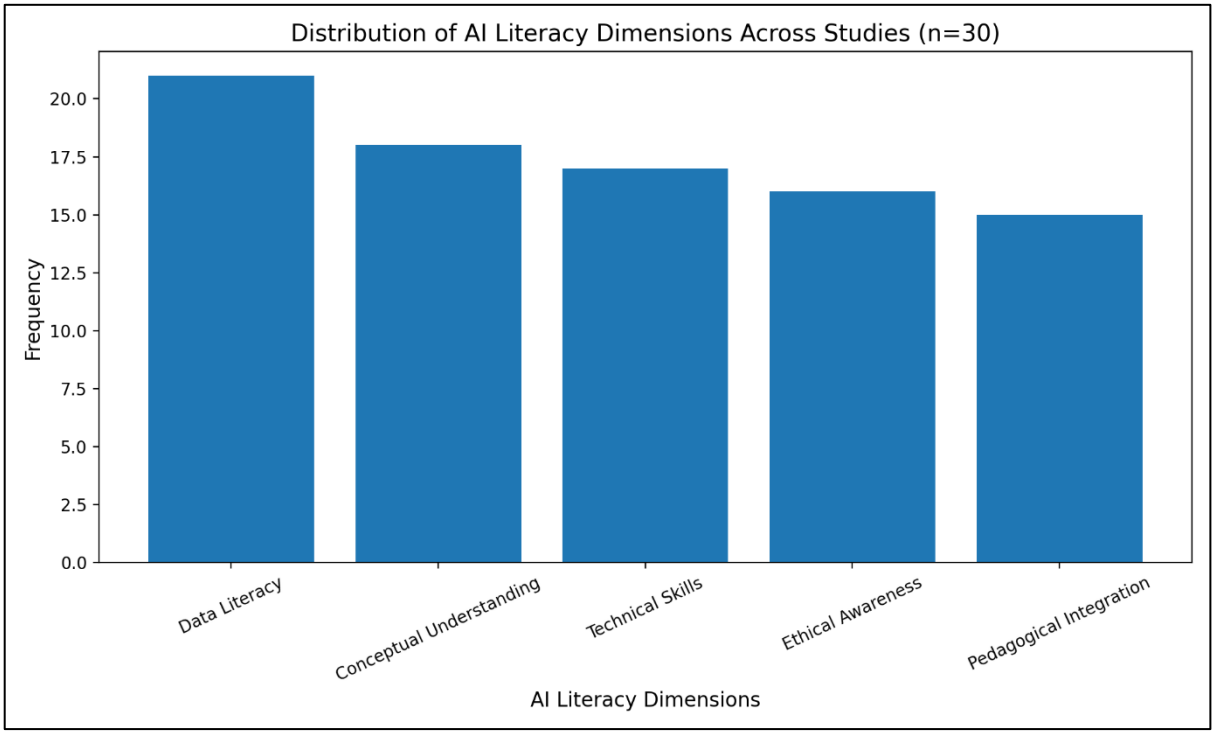

Figure: Conceptual dimensions of AI literacy identified across selected studies.

Core Dimensions of AI Literacy for STEM Teachers

This part of the paper will bring together the conclusions of the reviewed articles to determine the central aspects of Artificial Intelligence (AI) literacy among STEM teachers. The thematic analysis shows that AI literacy is a multidimensional variable that consists of five major areas conceptual knowledge, technical expertise, pedagogical integration, ethical understanding, and data literacy. All of these dimensions shape the competencies that one will have to possess in order to be able to interact with AI in the educational process.

Conceptual Understanding

The primary element of AI literacy is conceptual understanding. It is the understanding of basic AI concepts of machine learning, algorithms, neural networks, and automation on the part of teachers. A number of studies observe that lack of a fundamental understanding of the operation of AI systems can impair the ability of teachers to critically assess and appropriately implement AI systems and use them in teaching practice. This dimension also incorporates the knowledge of the capabilities and constraints of AI systems. The teachers also need to know what AI is capable of doing, as well as what it cannot and that is the issue of accuracy, reliability and interpretability. Consequently, the understanding of ideas may assist in making wise choices and work with AI technologies critically in STEM studies.

Technical Skills

The operational aspect of AI literacy is represented by the technical skills because they pay attention to the use of AI tools, platforms, and applications. This is to be familiar with AI-related learning programs, data-analytics programs and online platforms supporting AI-enhanced learning platforms. According to the available empirical

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

data, more technologically competent educators can implement AI-based solutions to classrooms more effectively. The technical skills encompass also the mere knowledge of programming, the exposure to AI interface, and the skills to trouble-shoot and modify the application of technological factors. The dimension plays an important role in practice of theoretical knowledge.

Pedagogical Integration

One of the considerations that relate AI literacy and instructional practice is the aspect of pedagogical integration. It involves the capacity to incorporate AI in instruction design, pedagogy and classroom experiences. It is expected that the teachers will enhance the degree of student interaction, differentiate the learning process, and enhance the assessment process with the help of AI. This aspect encompasses the architecture of AI-driven lesson plan, the adoption of intelligent tutoring software and integration of adaptive learning technology. It also implies that the AI tools require fitting in the curriculum goals and learning outcomes. The literature states that pedagogical competence plays a significant role in ensuring that AI is not implemented in education at a very shallow level.

Ethical Awareness

The problem of ethical awareness deals with the question of how AI can be utilized in an ethical way in educational institutions. The competencies such dimension includes are awareness of the issues of prejudice, data confidentiality, openness, and responsibility in the system of AI. As AI technologies are fast influencing the sphere of decision-making, the ethical aspects of AI should be remembered by teachers. Studies indicate the importance of the training of teachers on how to critically review the AI systems to become non-partisan and inclusive. The other level of ethical awareness is educating the students on how to be responsible in the use of AI and digital citizenship. The dimension is particularly vital and imperative in the undertaking of making sure that AI integration with more broad-based societal and education values occurs.

Data Literacy

Data literacy is the ability to analyze, understand, and put data produced by AI systems into practice. The most common challenge in the educational setting of AI-powered systems is that teachers have to decide based on the data and make informed decisions when relying on student performance and learning trends. The dimension includes knowing how to collect data, visualization interpretation, and using data to revise teaching strategies. Data literacy allows the teacher to make AI impressions work to their benefit, which improves teaching performance and student performance.

Table: Thematic Mapping of AI Literacy Dimensions (Codes → Themes → Dimensions)

Codes	Themes	Dimensions
AI concepts, ML, algorithms	Foundational AI knowledge	Conceptual Understanding
Neural networks, automation	System awareness	Conceptual Understanding
AI tools, software usage	Technical proficiency	Technical Skills
Programming basics, platforms	Operational capability	Technical Skills
AI-based teaching tools	Instructional integration	Pedagogical Integration
Adaptive learning, tutoring AI	Teaching innovation	Pedagogical Integration
Bias in AI, fairness	Ethical responsibility	Ethical Awareness
Privacy, accountability	Responsible AI usage	Ethical Awareness
Data interpretation	Analytical skills	Data Literacy
Learning analytics	Data-driven decision making	Data Literacy

Pedagogical Applications of AI in STEM Education

The integration of the Artificial Intelligence (AI) into the field of STEM education has led to the surge in new pedagogical approaches that have a significant impact in terms of the effectiveness of the instruction and achievement of student learning outcomes. The empirical studies examined in this paper show that there has been a gradual implementation of AI to strengthen teaching methods, personalize the learning process of individual students, and improve the assessment and curriculum development.

Teaching Strategies using AI

One of the most important spheres of implementation is the AI-assisted instructional techniques, which allows the teacher to provide more personal and efficient learning. The most noticeable one is the application of intelligent tutoring systems, which is grounded on the individualised guidance, which is anchored on the pace and performance measures of a learner. These systems replicate the one-to-one tutoring, through the provision of real-time explanations, problem-solving assistance in addition to adapting content. The other application which has turned out to be relevant is the adaptive learning sites where learning material and learning paths are adjusted to the capabilities and developments of the students. The sites deliver tailored content with the assistance of the AI algorithm that processes the learner information; this helps in communication and enhancing learning. Adaptive learning can particularly be a good approach to learning in STEM-based courses as the students usually exhibit different levels of comprehension. In addition, the simulation tools based on AI are popular in designing the interactive and immersive learning. They are tools that enable the students to experimentally operate with complex scientific and engineering systems within a virtual environment and therefore, provide an opportunity to engage in experiential learning. The simulation also provides the possibility of exploration of the scenarios that would be otherwise unattainable in the traditional classroom at minimum costs and in a harmless manner.

AI use in Assessment.

The fact is that, AI has drastically transformed the methods of assessment in STEM education bringing more efficient and accurate assessment procedures. Assignments, quizzes, and even the work in complex problems can be graded with the assistance of AI-based systems and this will minimize the number of instructional work and provide consistency in grading. Furthermore, AI aids in the formative assessment through constant monitoring of student performance and pinpointing learning areas, and thus, enabling the intercession and accurate assistance. The artificial intelligence-based evaluation systems also possess granular analytics that could assist teachers in knowing the student directions and learning trends more precisely.

Role of AI in Feedback

Feedback is one of the crucial aspects of the efficient teaching process and AI has immensely increased feedback quality and immediacy. The AI systems will provide a learner with an instant and personalized feedback, and a learner will be able to correct his or her errors and improve his or her understanding in real-time. This quality comes in particularly handy in STEM education where timely feedback cannot be overemphasized in terms of learning any complex topic. The AI-based feedback systems also help teachers by giving them insights about student performance, and thus, make more prudent teaching choices. Recurrent errors, suggestions of better learning methods, and identification of mistakes can be initiated, with the help of automated feedback systems.

Role of AI in Curriculum Innovation

AI still has a radical impact on curriculum development and innovation. The implementation of AI in the STEM curricula implies the introduction of new material related to the concept of AI, as well as the restructuring of the current curricula to incorporate the use of AI-based learning opportunities. The AI supports the development of adaptable and changing curricula that can adapt to changing technological changes and student requirements. It also encourages the interdisciplinary approach to learning by integrating the AI concepts into the specific areas

of STEM. Also, the insights provided by AI can guide curriculum design, as they can identify new skills and competencies that are required in the modern professional environment.

Challenges and Barriers

Although the introduction of the Artificial Intelligence (AI) into STEM education has a great potential, it comes with a variety of meaningful issues and obstacles that hinder its successful adoption. Through systematic reviews, it has been discovered that some limitations are common to several studies and the limitations can be generalized into training, infrastructure, ethics, adoption, and policy concerns. All these barriers do not only affect teacher preparation but also define the scalability and sustainability of AI-based educational processes. One of the most obvious problems is the insufficiency of training of teachers. As it has been empirically demonstrated, STEM teachers tend to be unprepared to engage AI in learning operations as they are not exposed, they have no proper professional development prospects, or structured training programs. Such lack of knowledge decreases the confidence of the teachers and reduces their skills to apply AI tools in the classroom. The other limiting aspect factor is connected with the infrastructure constraints particularly in developing regions. The successful implementation of AI in the education industry needs a constant internet connection, modernized hardware, and AI-based systems. However, one of the bottlenecks affecting the application of AI-based teaching techniques is technological resources since different institutions are limited by them. Another issue that poses a big challenge is the question of the ethical and privacy. The implementation of AI systems is linked to the gathering and processing of immense volumes of data about students, and the concerns about the security and confidentiality of information and their misuse emerge. Moreover, there are ethical issues of AI systems of algorithmic bias and lack of transparency that may plague teachers. Other obstacles that have been discovered in the literature are lack of adoption. Some educators do not also show much interest in AI technologies due to the fear of the inability to cope with the technologies or the perceived threat to conventional teaching tasks, or they lack trust in AI technologies. The absence of adequate training is likely to cause this resistance and the inadequate knowledge of the advantages of AI. Finally, another aspect of the structure to consider in integrating AI in education is policy gaps. Guidelines, structure, and regulation of AI use are not explicitly implemented in many systems of education. The absence of standard policies induces inconsistency in the adoption and limits the integration on a large scale.

Table: Thematic Categorization of Challenges and Barriers

Challenge Category	Specific Issues Identified	Impact on AI Integration
Teacher Training	Lack of AI knowledge, insufficient training programs	Low teacher readiness and confidence
Infrastructure	Limited access to technology, poor connectivity	Restricted implementation of AI tools
Ethical and Privacy	Data security concerns, algorithmic bias	Reduced trust and ethical challenges
Resistance to Adoption	Fear of technology, reluctance to change	Slow adoption of AI-based practices
Policy and Governance	Lack of guidelines, absence of regulatory frameworks	Inconsistent and fragmented implementation

Table 3.7: Frequency of Challenges Reported Across Studies

Challenge Category	Frequency (No. of Studies)
Teacher Training	24
Infrastructure	20
Ethical and Privacy	18
Resistance to Adoption	15
Policy Gaps	14

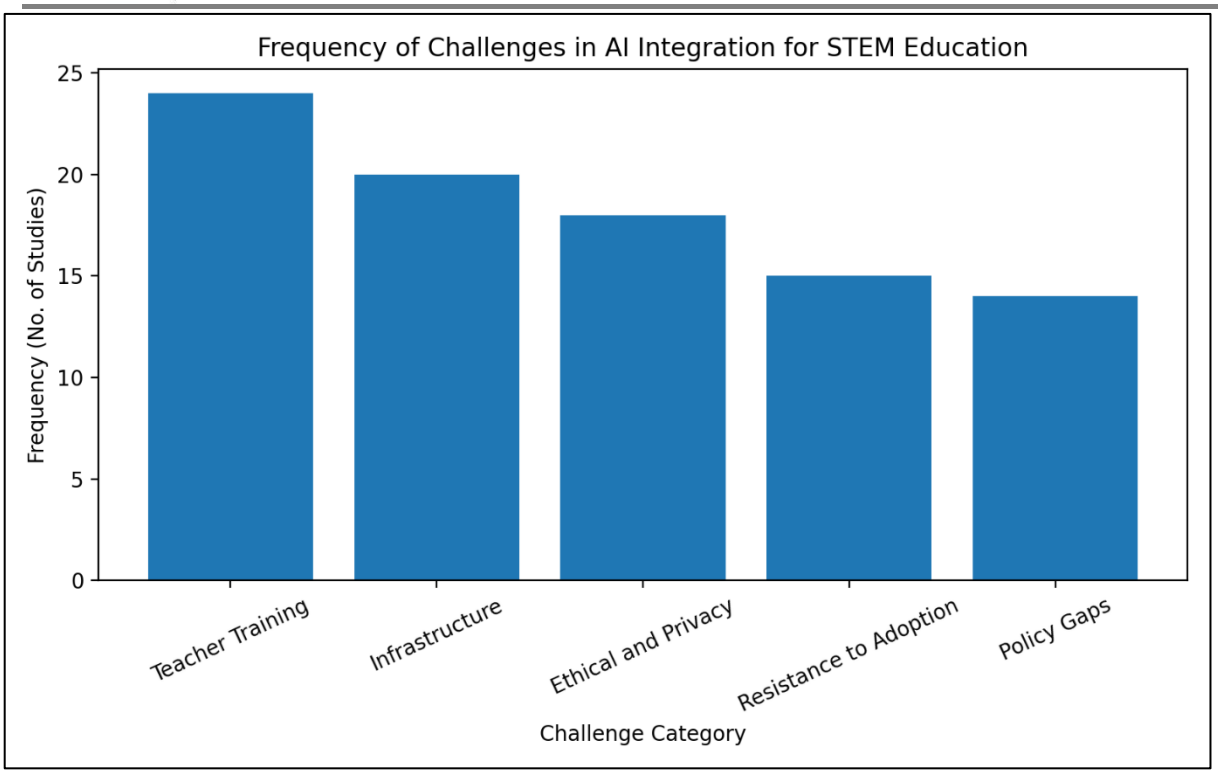

Figure: Frequency distribution of challenges affecting the integration of AI in STEM education,

Recent Trends in AI Literacy Research

The present analysis of the selected articles shows that there are certain new trends that are emerging as the defining factors of the development of Artificial Intelligence (AI) literacy in the STEM education. These inclinations represent a driftage of an investigational study towards an organized provision, policy inclusiveness, and accommodation to the orthodox educational practice. These findings demonstrate that AI literacy does not pose as an independent technical skill anymore but turns out to be one of the most significant constituents of the modern educational systems. The growing popularity of AI-based curriculum is one of the most remarkable trends. The schools and colleges are starting to introduce AI ideas both in the form of standalone courses or as specialised modules to the existing ones within STEM programs. This also implies the introduction of machine learning, data analytics and ethical AI. The trend towards the integration of the curriculum is based on the reality that students will require AI literacy to be ready to work in the future. As research has revealed, the redesigning of curricula is moving to competency based models that emphasize not only on the theory, but also on its practical implementation. One more significant tendency is interdisciplinary approach to teaching. The field of AI literacy is on the intersections of a number of disciplines, including computer science, mathematics, education, and social sciences. This kind of interdisciplinary approach can assist in making students understand AI as a socio-technical phenomenon with both ethical, economic, and societal repercussions and a technical tool. The tendency to develop an encouraging trend among teachers about building learning experiences where AI concepts can be connected to real-life problems within different subject areas continues to grow. The other significant trend is the rising trends in professional development programs amongst the teachers. After locating the discrepancy in teacher readiness, governments and learning institutions invest in training programs that are likely to eliminate the differences in AI competencies among teachers. They include such programs as workshops, online programs, certification programs and learning communities. It is focused on empowering the teachers with technical and pedagogical strategies that might be effective in implementing AI. Learning throughout the life is becoming a component and a subset of AI literacy development. In addition to that, policy development at the policy level is also playing a part in the research and practice in AI literacy. The governments and educational institutions are trying even harder to create policies, guidelines, and strategic plans to supplement the application of AI in education. The policies are focused on such issues as curriculum standards, responsible usage of AI, data management, and the construction of infrastructure. There should be policy encouragement that will facilitate the growth of AI projects and allow some standardization in the education systems.

Table 3.10: Synthesis of Key Findings Across Themes

Theme Area	Key Findings	Implications
Conceptualization	Lack of uniform definition; emerging multidimensional frameworks	Need for standardized AI literacy framework
Core Dimensions	Five key dimensions identified	Basis for competency development
Pedagogical Applications	AI enhances teaching, assessment, and curriculum	Improved teaching effectiveness
Challenges	Training, infrastructure, ethical concerns	Need for capacity building and support
Emerging Trends	Curriculum integration, policy development	Movement toward institutional adoption

Table 3.11: Dominant Patterns Identified Across Studies

Pattern Identified	Description
Shift toward holistic frameworks	Integration of technical, pedagogical, and ethical dimensions
Increasing importance of AI in STEM	AI becoming essential in teaching practices
Teacher preparedness as key factor	Training and skills influence adoption
Alignment with policy developments	Growing institutional and governmental support
Convergence of challenges and trends	Solutions emerging alongside identified barriers

CONCLUSION

The present study gives the intensive synthesis of the existing literature on the subject of Artificial Intelligence (AI) literacy of STEM teachers through the systematic approach of the review that is held to the PRISMA recommendations. The results indicate that AI literacy is a multidimensional concept which is not only dynamic but also not only technical, but also pedagogical, ethical, and data literacy. The development of this aspect demonstrates a paradigm shift within the education sector, in which not only the teachers are expected to be aware of AI technologies, but also apply them to the most helpful and responsible manner to a teaching-learning process. Perhaps one of the greatest contributions of the research was the list of five priority dimensions of AI literacy conceptual knowledge, technical competencies, pedagogical integration, ethical awareness, and data literacy, which has established a full picture of knowledge that can be applied to teacher education, curriculum planning, and scholarship in the future. The synthesis also indicates that despite the fact that the technical and conceptual elements are still considered to be primary, there is the tendency to pay more attention to pedagogical implementation and ethical aspects, which is the indication of the shift to more holistic and practice-based models. The paper also defines some serious obstacles to the effective implementation of AI into STEM education. Issues like a lack of teacher training, infrastructure, ethical concerns, adoption opposition, and policy weaknesses still pose a hindrance to the comprehensive adoption of AI-based learning. At the same time, new trends, such as AI-based curriculum, interdisciplinary pedagogy, professional development programs, and policy-based improvements point to the growing awareness of the need to teach AI literacy as an important part of the educational system worldwide. However, the lack of standard definition and model of AI literacy is the major shortcoming of the domain. Such inconsistency makes the research not so comparable and creates barriers to creating consistent educational programs. To this end, it is now more than ever necessary to come up with standardized models and assessment tools that can help to create a common ground between research and practice.

REFERENCES

1. Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.
2. Kitchenham, B., Brereton, P., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). Systematic literature reviews in software engineering: A systematic literature review. Information and Software Technology, 51(1), 7–15. https://doi.org/10.1016/j.infsof.2008.09.009
3. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71
4. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039
5. Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. Journal of Planning Education and Research, 39(1), 93–112. https://doi.org/10.1177/0739456X17723971
6. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
7. Critical Appraisal Skills Programme (CASP). (2018). CASP qualitative checklist. https://casp-uk.net/casp-tools-checklists/
8. Kitchenham, B., Brereton, P., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). Systematic literature reviews in software engineering: A systematic literature review. Information and Software Technology, 51(1), 7–15. https://doi.org/10.1016/j.infsof.2008.09.009
9. Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado López-Cózar, E. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. Journal of Informetrics, 12(4), 1160–1177. https://doi.org/10.1016/j.joi.2018.09.002
10. Mixed Methods Appraisal Tool (MMAT). (2018). MMAT version 2018: User guide. McGill University. http://mixedmethodsappraisaltoolpublic.pbworks.com
11. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. PLoS Medicine, 6(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097
12. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71
13. Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. Journal of Planning Education and Research, 39(1), 93–112. https://doi.org/10.1177/0739456X17723971
14. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. International Journal of Educational Technology in Higher Education, 16(1), 39. https://doi.org/10.1186/s41239-019-0171-0
15. Bond, M., Marín, V. I., Dolch, C., Bedenlier, S., & Zawacki-Richter, O. (2018). Digital transformation in German higher education: Student and teacher perceptions and usage of digital media. International Journal of Educational Technology in Higher Education, 15(1), 48. https://doi.org/10.1186/s41239-018-0130-1
16. Chiu, T. K. F., Meng, H., Chai, C. S., King, I., Wong, S., & Yam, Y. (2021). Creation and evaluation of a pre-tertiary artificial intelligence (AI) curriculum. IEEE Transactions on Education, 64(4), 303–309. https://doi.org/10.1109/TE.2021.3085829
17. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.
18. Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. Pearson Education.
19. Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. Computers and Education: Artificial Intelligence, 2, 100041. https://doi.org/10.1016/j.caeai.2021.100041

20. OECD. (2021). Artificial intelligence and education: Guidance for policymakers. OECD Publishing.
21. Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. International Journal of Artificial Intelligence in Education, 26(2), 582–599. https://doi.org/10.1007/s40593-016-0110-3
22. Selwyn, N. (2019). Should robots replace teachers? AI and the future of education. Polity Press.
23. Tuomi, I. (2018). The impact of artificial intelligence on learning, teaching, and education: Policies for the future. European Commission Joint Research Centre.
24. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. International Journal of Educational Technology in Higher Education, 16(1), 39. https://doi.org/10.1186/s41239-019-0171-0