

On the Measurement of AI Literacy Among Students in Higher Education: A Scoping Review

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Abstract

Artificial intelligence (AI) literacy is essential in higher education. This scoping review maps how AI literacy is measured among higher education students. Using Arksey and O’Malley’s (2005) five-stage framework, we searched five databases, screened 190 records, and included 39 studies. We synthesized definitions, instruments, construct dimensions, theoretical frameworks, related variables, and geographic contexts. Findings indicate emerging consensus that AI literacy is multidimensional, commonly covering knowledge, application, evaluation, and ethics. Research was largely quantitative and self-report; the Artificial Intelligence Literacy Scale (AILS) (Wang et al., 2022) was the most frequently used measure. Few studies used objective tests or mixed methods, limiting evidence of demonstrated competence. AI literacy was often examined alongside attitudes, self-efficacy, and adoption intentions. Studies were concentrated in East Asia, with fewer from Europe, North America, and the Middle East. This review highlights needs for performance-based assessment, clearer boundaries between AI and generative AI literacy, and broader geographic coverage.

Keywords: generative AI, AI literacy, higher education

Introduction

Artificial intelligence (AI) literacy has rapidly emerged as a critical competence in contemporary society, necessitated by the pervasive integration of AI technologies into education, work, and daily life (Long & Magerko, 2020; Ng et al., 2021a). In higher education, students must be prepared to navigate an increasingly AI-driven academic and professional environment (O’Dea et al., 2024; K. Chen et al., 2025). As a result, researchers have devoted growing attention to conceptualizing and fostering AI literacy.

Recent scholarship has moved beyond defining AI literacy to developing and validating assessment frameworks and instruments for diverse populations. Across studies, measurement has ranged from self-assessed competencies (e.g., awareness, use, evaluation, ethics) to smaller sets of objective knowledge tests, with growing attention to the overlap and boundaries between “AI literacy” and “generative AI literacy.” Because measurement choices shape what counts as literacy, the field’s rapid instrument growth has created both opportunities for comparability and risks of conceptual drift.

A focused synthesis of measurement approaches for higher education students is therefore needed. Unlike reviews centered on teachers, professional training, or course design, this scoping review concentrates on how AI literacy is operationalized and assessed among university students—including the instruments used, the constructs they capture, and the methodological patterns that influence validity and interpretability. Mapping this measurement landscape can guide researchers toward more rigorous, transparent, and comparable assessment practices.

Several scoping reviews have aimed to synthesize aspects of this growing body of work. For example, Sperling et al. (2024) explored AI literacy in teacher education. Laupichler et al. (2022) focused on AI literacy in high and adult education around theme, definitions, and courses teaching AI content. And Tang and Zang (2025) addressed AI literacy instruments for teachers. These studies demonstrate the value of mapping the field, but their focus has not been on the measurement of AI literacy among students in higher education.

Addressing this need, the present scoping review systematically maps the current landscape of AI literacy measurement in higher education. Specifically, it identifies how AI literacy is defined, the methods and instruments used for its assessment, the constructs being measured, the theoretical frameworks applied, and the geographical contexts of student populations. In doing so, this review contributes to standardizing measurement approaches, highlighting validated tools for broader use, and revealing gaps for future inquiry. It aims to answer the following questions:

1. What are the current conceptualizations and definitions of AI literacy in higher education?
2. What research methods (e.g., quantitative, qualitative, mixed-methods) are used to study AI literacy in higher education?
3. What measurement tools and scales are being used to assess AI literacy among university students, and what is their nature (e.g., self-assessment versus objective knowledge tests)?
4. What are the constructs or dimensions of AI literacy assessed in studies among university students?
5. What theoretical frameworks and models are most employed in studies investigating AI literacy?
6. What other variables are most frequently studied in relation to AI literacy?
7. What are the geographical contexts of student populations in higher education primarily represented in existing research on AI literacy?

Methods

This study followed the five-stage scoping review framework proposed by Arksey and O'Malley (2005), which includes: (1) identifying the research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing, and reporting the results.

Protocol and reproducibility. A review protocol was developed prior to study selection to specify research questions, eligibility criteria, databases, search string, screening steps, and data charting fields. The protocol was not registered in a public repository; however, the full protocol, screening log, and data extraction template are available from the authors upon request to support reproducibility.

Identifying Relevant Studies

A systematic search was conducted on June 12, 2025, across five academic databases: Scopus, Web of Science, IEEE Xplore, PubMed, and ERIC. The search was limited to titles, abstracts, and keywords using the following search string:

Database rationale. Scopus and Web of Science were selected for broad, multidisciplinary coverage and citation indexing. ERIC was included to capture education-focused scholarship,

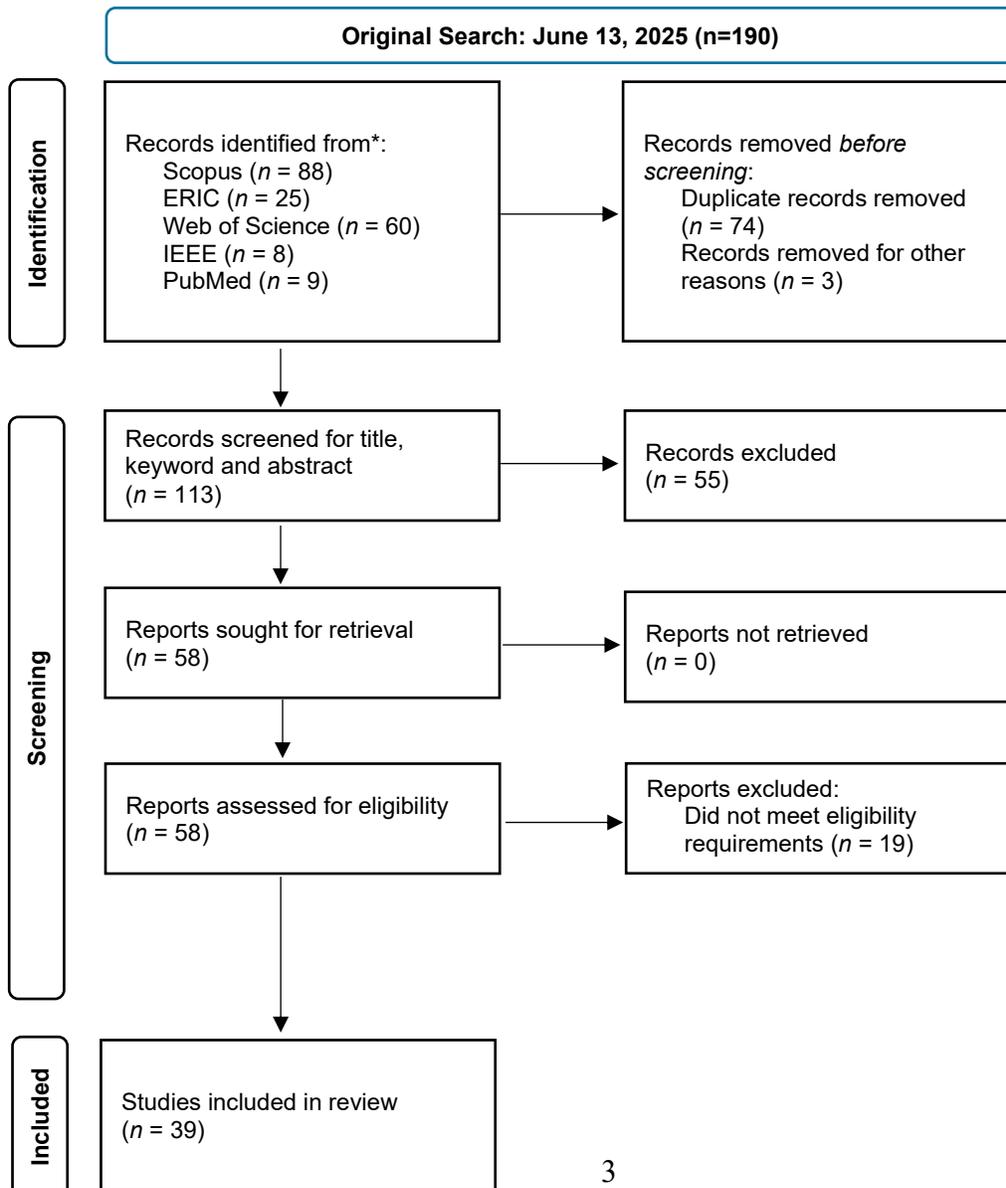
while PubMed was included to identify health and medical-education studies where AI literacy measures may be applied to student populations. IEEE Xplore was included to capture computing- and engineering-adjacent education research and conference proceedings where AI literacy instruments and student assessments are frequently reported. We acknowledge that IEEE Xplore is not a comprehensive engineering index; future updates could expand coverage by adding Compendex (Engineering Village) for more systematic engineering and applied AI indexing.

("AI literacy" OR "AI read*") AND ("higher education" OR "tertiary education")) AND (student* OR learner*) AND (instrument OR question* OR measur* OR survey OR scale)
 The initial search yielded 190 records.

Study Selection

All records were imported into reference management software (EndNote). Duplicates ($n = 74$) and records for entire conference proceedings ($n = 3$) were removed. This left 113 unique records for a two-stage screening process (see Fig. 1).

Fig. 1: Study selection



In the first stage, titles and abstracts were screened against the inclusion and exclusion criteria (see Table 1), which included empirical studies written in English that explicitly measured AI literacy in higher education students between January 1, 2021, and June 12, 2025. This stage excluded 55 papers, leaving 58 for full-text review.

Screening procedures. Screening was completed in two stages (title/abstract, then full text) using the predefined eligibility criteria. Screening decisions and reasons for exclusion at full text were recorded to support auditability. Any uncertainties during screening were resolved through author discussion until consensus was reached.

Table 1: Inclusion and exclusion criteria

Inclusion	Exclusion
AI literacy in higher ed	Studies focusing solely on perceptions/behaviors without an explicit AI literacy measure
Used AI literacy measurement tools	Grey literature
Explicitly measured AI literacy in current students	Lit reviews
Empirical studies	AI literacy for faculty
Written in English	Non-empirical studies
Published between 01/01/2021-6/12/2025	

In the second stage, the full texts of the remaining 58 articles were reviewed, and 19 were excluded for not meeting the inclusion criteria. This resulted in a final selection of 39 studies for analysis in this scoping review.

Charting the Data

A data charting table was created to extract relevant information from the final 39 articles. The table included bibliographic details, study design, research method, measurement tools used, AI literacy constructs assessed, theoretical frameworks employed, related constructs studied, and the geographical location where the study was performed.

Data extraction template. The data charting form was piloted on a small subset of included studies and refined before full extraction. Fields included citation details, participant population, country/region, study aim, method/design, AI literacy definition, instrument name/source, construct dimensions, item type (self-report vs. objective), reliability/validity evidence (when reported), theoretical framework, and related variables. The finalized extraction template is available upon request.

Collating, Summarizing, and Reporting Results

In the final stage, the charted data from the 39 papers was collated and synthesized using a mixed-analytical approach. A descriptive quantitative analysis was performed to identify frequencies and trends related to publication years, research methods, definitions, and measurement tools. This was complemented by a qualitative analysis to identify broader conceptual themes and trends across the literature. The combined results were then summarized

narratively to map the current state of AI literacy measurement in higher education, as presented below.

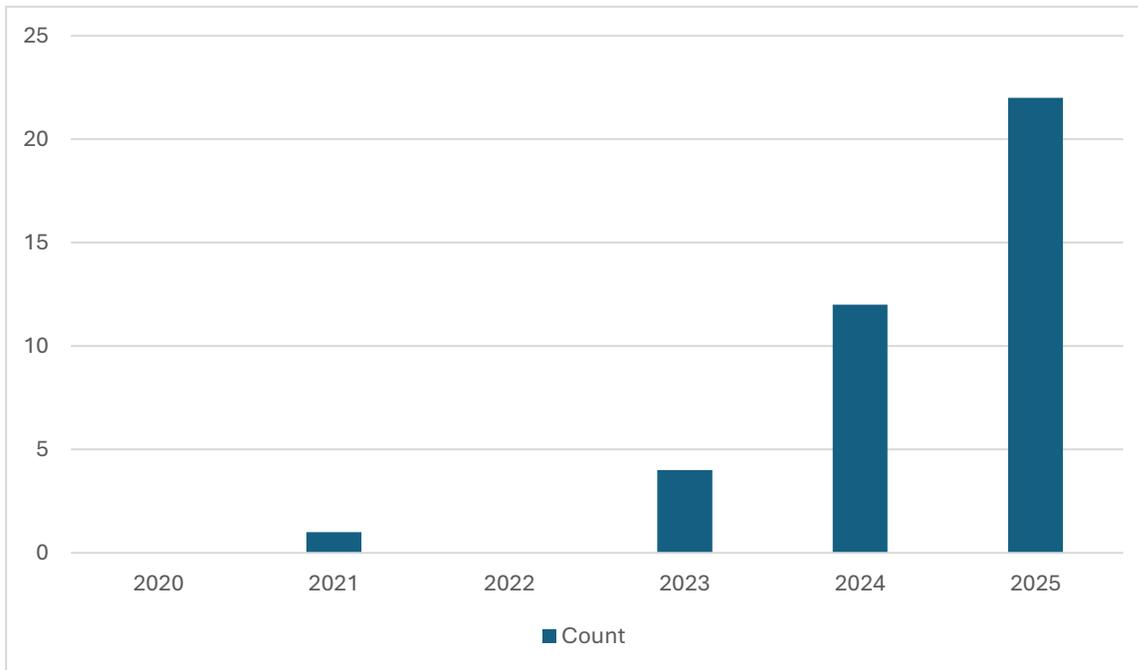
Limitations

This scoping review, while systematic, has several limitations. The search strategy was restricted to five major academic databases and excluded grey literature, such as dissertations and institutional reports, which may contain relevant data. The exclusion of non-English language articles may have introduced a language bias and omitted valuable research from other regions. Finally, as a scoping review, this study maps the existing literature without assessing the methodological quality of the included articles. Therefore, the findings represent the state of the field as it is published, not necessarily the quality of the research being conducted.

Results

The analysis of the 39 included papers is organized below according to the seven research questions that guided this review. While not a research question, measurement of AI literacy among higher education students has grown in recent years (see Figure 2). The search revealed the following concerning year of publication:

Fig. 2: Publications by year



RQ1: Conceptualizations and Definitions

There is no one universally agreed upon definition of AI literacy, although this review found a few prominent sources for its definition and conceptualizations. The most frequently quoted definition is from Long and Magerko (2020), who define AI literacy as "a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace." Five papers quote them verbatim (Al- Abdullatif et al., 2024; Bewersdorff et al., 2025; K. Chen et al., 2024;

Hornberger et al., 2023; and Ma & Chen, 2024) and 16 other papers cite, summarize, or synthesize their definition into their own. Other influential sources on the conceptualization of AI literacy come from Ng et al. (2021a, 2021b, 2023) and B. Wang et al. (2022), which build upon this foundation by further specifying ethical and practical dimensions. Twenty-nine papers cite Ng and colleagues, who conceptualize AI literacy into four domains: know and understand AI, apply AI, evaluate and create AI, and AI ethics. Eighteen papers cite B. Wang et al. (2022), who similarly conceptualizes AI literacy into four components: awareness, usage, evaluation, and ethics. Ng and colleagues later created a framework with four new domains: affective, behavioral, cognitive, and ethical (Ng et al., 2024).

RQ2: Research Methods

The research landscape is dominated by quantitative approaches. Of the 39 studies, 31 were quantitative and 8 used a mixed-methods design. No purely qualitative studies were identified, although one mixed-methods study performed a quantitative sentiment analysis on qualitative data (Dong et al., 2025). The primary research aims of the included studies can be classified into three main categories (see Table 2). The largest group, comprising 26 studies, focused on measuring AI literacy and examining its relationship with other variables. The second category consists of studies focused on instrument development, with six studies aiming to validate a new AI literacy scale and one study focused on creating an objective knowledge test (Hornberger et al., 2023). The final group includes six studies that measured the effectiveness of a specific intervention designed to improve AI literacy.

Table 2: Research aim classification

Classification	Count	Author(s), Year
Relationship of AI literacy to other variables	26	Al-Abdullatif et al., 2024; Asio, 2024; Bewersdorff et al., 2025; Bui et al, 2023; K. Chen et al., 2025; S. Y. Chen et al., 2024; Dadhich & Bhaumik, 2023; Gökçe et al., 2025; Hossain et al., 2025; Imjai et al., 2025; Lee et al., 2024; Lilje et al., 2024; O’Dea et al, 2024; Qi et al., 2025; Samngamjan et al., 2024; Sari et al., 2025; Schauer et al., 2025; Shi et al., 2025; Skalka et al., 2025; Sprigi & Seufert, 2025; Swartz et al., 2025; Syed et al., 2025; C. L. Wang et al., 2025; K. Wang et al., 2025; Wen et al., 2025; Xiao et al., 2024
AI literacy instrument development	7	Biagini et al., 2023; Han & Zhang, 2025; Hobeika et al., 2024; Hornberger et al., 2023; Ma & Chen, 2024; Topal et al., 2025 Z. Wang et al., 2025

Classification	Count	Author(s), Year
Effectiveness of intervention on AI literacy	6	Dong et al., 2025; Kong et al., 2023; Korte et al., 2024; Lin et al., 2024; J. Wang, 2024; Younis, 2024

RQ3: Measurement Tools

The primary method for assessing AI literacy and other variables is the use of a self-assessment scale, with 38 out of 39 studies using this approach in some capacity. The most utilized tool for AI literacy measurement is the Artificial Intelligence Literacy Scale (AILS) developed by B. Wang et al. (2022), which was used or adapted in ten studies. Other prominent instruments include the Scale for the Assessment of Non-Experts' AI Literacy (SNAIL) by Laupichler et al. (2023), used in four studies, and a scale by Dai et al. (2020), used in three studies. The Meta AI Literacy Scale (MAILS) by Carolus et al. (2023) and the AI Literacy Questionnaire (AILQ) by Ng et al. (2024) were each used twice. In addition to these established tools, 13 papers reported using a scale developed by the researchers for their specific study.

A smaller number of studies ($n = 5$) employed objective knowledge tests to assess concrete understanding of AI concepts. One study was dedicated to the development and validation of such a test (Hornberger et al., 2023), which was then utilized in a subsequent study (Bewersdorff et al., 2025).

Finally, several of the mixed-methods studies ($n = 8$) incorporated qualitative tools to complement their quantitative data. These included open-ended survey questions, reflective diaries, and semi-structured interviews.

RQ4: Measured Constructs

AI literacy is consistently measured as a multi-dimensional construct (see Appendix). The appendix contains an exhaustive table of the AI constructs defined and measured by study. While specific terminology varies between studies, the measured constructs consistently converge around four core conceptual pillars: knowledge, application, evaluation, and ethics. The most common framework, used in ten studies and measured in the AILS scale (B. Wang et al., 2022), explicitly measures these four dimensions as awareness, usage, evaluation, and ethics. Other frameworks use different labels but capture similar ideas, such as technical understanding, practical application, critical appraisal (Laupichler et al., 2023). The cognitive component of these constructs ranges from deep technical AI knowledge (e.g., understanding machine learning steps and ability to create AI tools) (Hornberger et al., 2023) to general awareness of generative AI tools (O'Dea et al., 2024).

RQ5: Theoretical Frameworks

The studies included in this review draw upon a set of theoretical frameworks that can be broadly categorized into three main groups: psychology and technology adoption, psychology and learning, and AI-specific frameworks (see Table 3). The first group, psychology and technology adoption, includes models used to explain students' intentions to accept and use AI tools. The most prominent theory in this category is the theory of planned behavior (TPB), used in four studies (S. Y. Chen et al., 2024; Syed et al., 2025; C. L. Wang et al., 2025; Wen et al., 2025). This is followed by the technology acceptance model (TAM), used in two studies (Lijie et al., 2025; Syed et al., 2025). Other theories and models used once include the value-based model

(VAM) (Al-Abdullatif et al., 2024), the control value theory of achievement emotions (Shi et al., 2025), the stage of change theory (Imjai et al., 2025), the interest development model (Bewersdorf et al., 2025), the information systems success model (ISSM) and the expectation confirmation model (ECM) (Qi et al., 2025), and the science, technology, and society framework (Sari et al., 2025)

The second category consists of psychology and learning that frame the cognitive, motivational, and educational aspects of acquiring AI literacy. These include self-determination theory (SDT), used in three studies (Lijie et al., 2025; Shi et al., 2025; K. Wang et al., 2025), social cognitive theory, used in two studies (Bewersdorff et al., 2025; S. Y. Chen et al., 2024), and self-regulated learning (SRL), also used in two studies (Shi et al., 2025; K. Wang et al., 2025). Some studies utilized established educational frameworks like Bloom's Taxonomy (Han & Zhang, 2025; Kong et al., 2023; Korte et al., 2024) to structure the cognitive levels of AI literacy acquisition.

The third category is AI-specific frameworks, which ground the research in a particular conceptualization of AI literacy. The framework developed by Ng and colleagues was most frequently utilized (e.g., O'Dea et al., 2024; Shi et al., 2025; Spirgi & Seufert, 2025; Skalka et al., 2025). Other studies drew upon models like the diamond model of AI literacy (Swartz et al., 2025), AI-TPACK (Younis, 2024), and E-GPPE-C intelligent learning model (J. Wang, 2024). Skalka et al. (2025) drew upon several models: the UNESCO AI competency framework for Students, the ED-AI lit framework, and the K-12 AI competency framework. Biagini et al. (2023), Dong et al. (2025), Kong et al. (2023), and Younis (2024) each drew upon unique AI frameworks.

Table 3: Theoretical frameworks employed

Framework Category	Specific Theory/Model (Count)
Psychology and technology adoption	Theory of planned behavior ($n = 4$) Technology acceptance model ($n = 2$) Other single technology usage models ($n = 7$)
Psychology and learning	Self-determination theory ($n = 3$) Social cognitive theory ($n = 2$) Self-regulated learning ($n = 2$) Bloom's taxonomy ($n = 3$)
AI-specific frameworks	Ng et al.'s AI literacy framework ($n = 4$) Other single AI literacy frameworks ($n = 10$)

RQ6: Related Constructs

Outside of demographic data, which nearly every study collected, researchers frequently investigated AI literacy in conjunction with other variables. These can be organized into three broad categories. The first category is attitudes and perceptions, which captures students' feelings and beliefs about AI. This includes constructs such as attitudes toward AI, perceived usefulness, perceived enjoyment, interest in AI, and AI anxiety (K. Chen et al., 2025; Hobeika et al., 2024; Hornberger et al., 2023; Qi et al., 2025; Schauer et al., 2025; Syed et al., 2025; C. L. Wang et al., 2025).

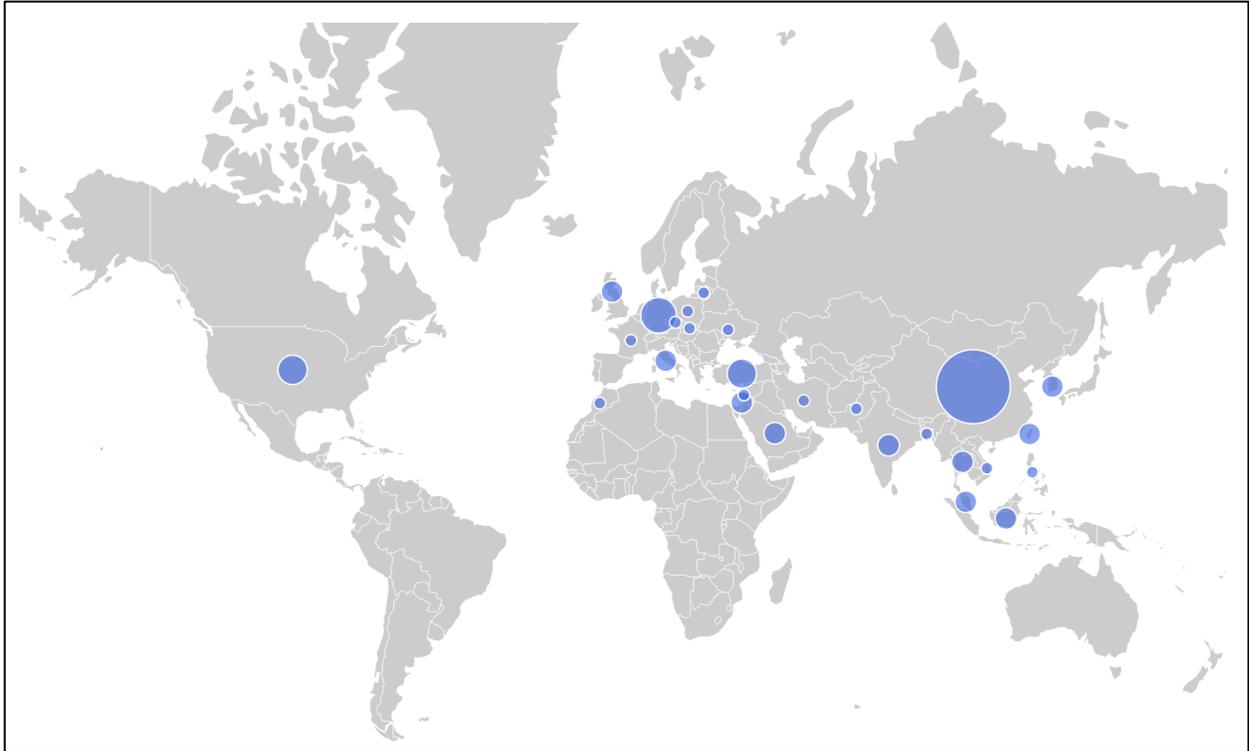
The second category involves cognitive and behavioral skills, which are personal attributes and competencies that may influence or be influenced by AI literacy. Key constructs in this area include self-efficacy (both general and AI-specific), self-competence, critical thinking, self-regulated learning, self-determination, digital skills, discipline-specific skills, GAI-driven wellbeing; writing performance, educational attainment, pedagogical knowledge, adaptability, and motivation (Asio, 2024; Bewersdorff et al., 2025; Bui et al., 2025; Dadhich & Bhaumik, 2023; Hornberger et al., 2023; Imjai et al., 2025; Lilje et al., 2025; Qi et al., 2025; Shi et al., 2025; K. Wang et al., 2025; Z. Y. Wang et al., 2025; Xiao et al., 2024).

The final group relates to technology use and intentions, which focuses on the practical application of AI. This includes variables such as use intention, continuous use, frequency of use, device ownership, and the direct outcomes of educational interventions designed to improve AI literacy (Al-Abdullatif et al., 2024; Bewersdorff et al., 2025; S. Y. Chen et al., 2024; Dong et al., 2025; Gökçe et al., 2025; Kong et al., 2023; Korte et al., 2024; Lilje et al., 2025; Lin et al., 2021; Qi et al., 2025; Sari et al., 2025; Spirgi et al., 2025; Syed et al., 2025; C. L. Wang et al., 2025; J. Wang, 2024; Wen et al., 2025; Younis, 2024).

RQ7: Geographical Contexts of Student Populations

The research on AI literacy measurement among students is geographically concentrated, with a significant majority of student populations originating from Asia. As illustrated in Figure 3, China (including Hong Kong) is the most represented country ($n = 13$). The next most frequently represented countries are Germany ($n = 4$), the United States ($n = 3$), and Turkey ($n = 3$). Students from the United Kingdom, Italy, Saudi Arabia, Taiwan, Malaysia, South Korea, Palestine, India, Thailand, and Indonesia were participants in two unique studies. And students from Vietnam, Philippines, Iran, Poland, Czech Republic, Slovakia, Lebanon, Morocco, Bangladesh, Pakistan, Lithuania, France, and Ukraine count were participants in one unique study. While this indicates that AI literacy is a topic of global interest, the current body of empirical research on its measurement is predominantly situated in East Asia, with a smaller but significant presence in Europe, the Middle East, and North America. The participants in all studies were higher education students from a wide range of disciplines, ages, and genders.

Fig. 3: Geographical distribution



Discussion

This scoping review mapped the current landscape of AI literacy measurement in higher education, revealing a rapidly maturing yet uneven field. A central finding is the increasing convergence of definitions around AI literacy as a multi-dimensional construct, typically encompassing knowledge, application, evaluation, and ethics (Ng et al., 2021a; B. Wang et al., 2022). This conceptual alignment has supported the growing adoption of standardized self-assessment instruments, particularly the Artificial Intelligence Literacy Scale (AILS), which has been heavily utilized in empirical studies (e.g., Hobeika et al., 2024; Ma & Chen, 2024). However, as the field coalesces around these core concepts, important questions about the boundaries of each construct emerge. For instance, future research will need to clarify whether ethics should be treated as a unique, standalone dimension or as a cross-cutting theme that is integrated within all other aspects of AI literacy.

AI literacy constructs for higher education students also show emphases that differ from frameworks developed for other populations. Compared with teacher-focused models that foreground pedagogical integration, instructional design, and classroom decision-making, student-focused instruments more often prioritize academic task use (e.g., learning support, writing support), individual adoption factors (e.g., attitudes, anxiety, self-efficacy), and responsible use in academic contexts (e.g., integrity, transparency, and ethical evaluation of outputs). Compared with professional or workforce-oriented frameworks that emphasize domain deployment, organizational governance, and job-specific risk management, higher-education student measures tend to emphasize foundational awareness and evaluative judgment needed to learn with AI across disciplines.

Despite this progress, several limitations in the literature constrain the robustness of current knowledge. First, the heavy reliance on self-assessment scales raises questions of validity. Self-perceptions may not accurately reflect students' demonstrated competencies,

particularly as generative AI tools shift expectations of what “literacy” entails. While objective instruments such as Hornberger et al.’s (2023) AI literacy test exist, their adoption remains limited. This reliance on perceptual measures risks reinforcing a narrow, potentially inflated understanding of AI literacy.

Second, the methodological dominance of quantitative approaches reflects a field focused more on validation than exploration. The few examples of qualitative and mixed-methods research limits insights into students’ lived experiences with AI, their sociocultural contexts, and the meaning-making processes underlying AI use. Without these perspectives, the field risks privileging surface-level generalizations over deeper, situated understandings of AI literacy development.

Third, conceptual ambiguities exist. Many measurement tools focus on broad technical knowledge of AI, while the rise of generative AI tools allows for engagement with AI without technical knowledge. O’Dea et al (2024) posits that a distinction should be made between AI literacy and generative AI literacy. This lack of clarity hinders the development of curricula and interventions tailored to today’s rapidly evolving AI landscape. Additionally, while many studies explored the relationship between AI literacy and other variables, there remains significant room to investigate how AI literacy interacts with a wider range of cognitive, affective, and behavioral factors.

Finally, the geographical concentration of studies, predominantly in East Asia, with smaller representation from Europe and North America, raises concerns about the cultural generalizability of findings. Cultural and educational contexts may significantly shape how AI literacy is conceptualized, assessed, and enacted. The current imbalance risks reinforcing region-specific perspectives as universal benchmarks.

Taken together, these trends suggest that while AI literacy measurement in higher education has advanced, it remains at a formative stage. Future progress will depend on expanding methodological diversity, clarifying constructs, and broadening global representation.

Conclusion

This scoping review provides a comprehensive overview of how AI literacy is being measured among students in higher education. The findings highlight an emerging consensus around core constructs and a growing reliance on validated self-assessment scales, particularly the AILS. At the same time, the field is marked by critical gaps: an overreliance on self-report, limited use of objective and performance-based measures, a lack of qualitative insight, conceptual ambiguities, and significant geographical imbalances.

Future researchers can address these gaps to advance both scholarship and practice. There is a need to prioritize the development and validation of objective assessments that capture demonstrated knowledge and skills, alongside qualitative approaches that illuminate students’ lived experiences and cultural contexts. Future studies should also differentiate between technical AI literacy and the specific competencies required for engaging with generative AI. Expanding research beyond East Asia to include underrepresented regions, such as Central and South America, Africa, and Australia, is particularly important for building a more global and inclusive understanding of AI literacy in higher education.

By addressing these methodological, conceptual, and geographical gaps, future research can move the field beyond fragmented measures toward more reliable and meaningful assessments of AI literacy. A stronger measurement foundation will not only improve research comparability but also inform the design of educational practices that prepare students for an AI-driven world.

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Appendix

AI Literacy Constructs Named, Defined, and Measured by Study

The following Table contains the list of AI literacy constructs, their definitions, and the studies that measured them. In cases where the researchers did not define their constructs, only the construct names are provided.

Construct Names and Definitions	Study
<p>Apply AI: operate and use AI in everyday life</p> <p>Understand AI: know AI concepts, define AI, think of uses for AI</p> <p>Detect AI: know if an application uses AI</p> <p>AI Ethics: incorporate ethical decisions when using AI</p> <p>Create AI: develop AI applications, select tools to program AI</p>	Asio, 2024 (from Carolus et al., 2023)
<p>Recognizing AI Interdisciplinarity</p> <p>Understanding intelligence</p> <p>General vs narrow</p> <p>AI's strengths and weaknesses, Representations</p> <p>Decision-Making</p> <p>ML steps</p> <p>Human Role in AI</p> <p>Programmability</p> <p>Data literacy</p> <p>Learning from data</p> <p>Critically interpreting data</p> <p>Ethics</p>	Bewersdorf et al., 2024 (from Hornberger et al., 2023)
<p>Knowledge-related dimension: it encompasses the understanding of fundamental AI concepts, focusing on basic skills and attitudes that do not require preliminary technological knowledge</p> <p>Operational dimension: it focuses on applying AI concepts in various contexts</p> <p>Critical dimension: it underscores the importance of effective communication and collaboration with AI technologies and critical evaluation of their impact on society.</p> <p>Ethical dimension: it concerns the responsible and conscious use of AI technologies</p>	Biagini et al., 2023

Construct Names and Definitions	Study
<p>Awareness: the ability to identify and comprehend AI technology during the use of AI-related application</p> <p>Usage: the ability to apply and exploit AI technology to accomplish tasks proficiently</p> <p>Evaluation: the ability to analyze, select, and critically evaluate AI applications and their outcomes</p> <p>Ethics: the ability to be aware of the responsibilities and risks associated with the use of AI technology</p>	<p>Bui et al., 2025; Hobeika et al., 2024; Ma & Chen, 2024; Qi et al., 2025; Sari et al., 2025; Shi et al., 2025; C. L. Wang et al., 2025; K. Wang et al., 2025; and Xiao et al., 2024 (from B. Wang et al., 2023)</p>
<p>Utilization: how students use generative AI for academic work</p> <p>Interaction: the methods students use to prompt and refine AI-generated outputs</p> <p>Evaluation: how students assess the quality, accuracy, and bias of AI-generated content</p> <p>Ethics: students' perceptions of academic integrity and the responsible use of AI</p>	<p>K. Chen et al., 2025</p>
<p>Technical understanding: competencies related to how AI works</p> <p>Critical appraisal: competencies related to the critical evaluation of AI application results</p> <p>Practical application: competencies related to technical applications of AI and solving problems with AI</p>	<p>Gökçe et al., 2025; Schauer et al., 2025; and Topal et al., 2025 (from Laupichler et al., 2023)</p>
<p>AI knowledge: the cognition of the concepts and logic in the field of AI</p> <p>AI application: the skillful use of AI technology to solve problems in different situations</p> <p>AI attitude: an individual's feelings and beliefs regarding AI usage.</p> <p>AI ethics: the ability to recognize ethical responsibilities and avoid risks and moral issues</p> <p>AI innovation: an experimental mindset and the capacity to apply technologies to deal creatively with real-world problems</p>	<p>Han & Zhang, 2025</p>

Construct Names and Definitions	Study
<p>Familiarity: AI awareness, recognition, and usage experience</p> <p>Knowledge & Application: conceptual and technical AI knowledge and understanding</p> <p>Ethical Perceptions: AI impact on academic integrity and related realms</p>	Hossain et al., 2024
<p>AI Basics: understanding the basics of AI</p> <p>AI Proficiency: the skilled and efficient application of AI</p> <p>Insight: the ability to accurately interpret AI data and outcomes</p> <p>Analysis: skills in using AI for complex analyses and decision-making related to data evaluation and application</p>	Imjai et al., 2025
<p>Cognitive: understanding basic AI concepts (like machine learning and deep learning) and developing competencies to apply them</p> <p>Affective: feeling empowered to confidently participate in an AI-driven world (including self-efficacy and seeing the value of AI)</p> <p>Sociocultural: having an awareness of the ethical issues surrounding AI</p>	Kong et al., 2023
<p>Affective learning comprises four factors that measure students' subjectively experienced feelings in terms of (1) intrinsic motivation; (2) self-efficacy; (3) career interest; and (4) confidence in learning AI</p> <p>Behavior learning comprises two factors: (1) students' behavioural commitment and (2) collaboration to build relationships to pursue learning goals in an AI environment</p> <p>Cognitive learning: comprises three factors: students' knowledge and skills achievement from (1) lower- (know and understand AI), (2) mid- (use and apply AI) to (3) high-order thinking skills (evaluate and create AI)</p> <p>Ethical learning: comprises a set of seven ethical aspects: (1) reliability, (2) safety, (3) privacy, (4) responsibility, (5) transparency, (6) awareness and (7) social good that bring students' positive mindsets towards AI</p>	Lilje et al., 2025; and Spirgi & Seufert, 2025 (from Ng et al., 2024)

Construct Names and Definitions	Study
Teamwork Attitude toward AI	Lin et al., 2021
Knowledge: acquiring the fundamental knowledge of AI and how to use AI tools Application: understanding of how particular AI tools can be used in different scenarios and to assist users to complete tasks efficiently and creatively. Evaluation: selecting the most appropriate AI tools, analyzing and evaluating AI outputs Ethics: an umbrella term and is concerned with areas such as fairness, accountability, and transparency.	O’Dea et al., 2024
Knowledge and use of AI Creation of AI AI self-efficacy AI self-Competency	Samngamjan et al., 2024 (adapted from Carolus et al., 2023)
Satisfaction: perceived satisfaction with AI learning Readiness: confidence in using AI tools and the perception of AI’s impact on daily life and personal development Relevance: perceived usefulness of AI tools for self and others	Skalka et al., 2025
Application: understanding both the benefits and challenges of individual AI tools, as well as the ability to utilize them depending on the task Authenticity: requires the AI users to incorporate their own voices, adjusting tone and sentiment according to the situation Accountability: ability to discern content critically, comply with ethical and legal standards and thus ensure the fair and equitable use of AI tools Agency: AI is utilized and controlled by humans and not vice versa	Swartz et al., 2025 (from Cardon et al., 2023)
Know/understand: understanding of technical knowledge of how AI works	Syed et al., 2025 (adapted from Dai et al., 2020)