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AI Literacy and Cognitive Evolution in Generation Z: A Synthesis of Empirical Evidence and Workshop-Based Insights

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ABSTRACT: Generative artificial intelligence has transformed from a niche research tool into an ambient feature of daily life for Generation Z (Gen Z), reshaping how this cohort learns, thinks, and prepares for professional futures. This manuscript synthesizes evidence from a systematic literature review (SLR) of 65 peer-reviewed sources spanning 2016 to 2026 with empirical findings from a cross-sectional descriptive-correlational study of 41 high school students at SMK Pembangunan JAYA YAKAPI, Indonesia. Following the PRISMA 2020 protocol, the SLR draws on Scopus, CRIS Reference, and Google Scholar databases. The empirical study assessed students' AI literacy across three subscales—AI understanding and usage, critical and ethical AI literacy, and career and future readiness—and examined their responses to a structured AI literacy workshop. Preliminary Cronbach's alpha values of 0.886 for the AI literacy scale and 0.940 for the workshop response scale indicate strong instrument reliability. A Spearman rank correlation of approximately 0.60 ($p < 0.001$) between AI literacy and workshop response scores was found among matched respondents, indicating a moderately strong positive association. The synthesis reveals a persistent paradox: while the majority of Gen Z students regularly use AI tools, fewer than 25% can demonstrate foundational knowledge of how these systems operate or govern user data. The AI Literacy is proposed as a practical and theoretically grounded curriculum framework integrating functional, critical, and ethics literacy dimensions. The evidence collectively positions AI ethics literacy as the most consequential lever available to educators seeking to protect intellectual autonomy in an AI-saturated learning environment.

KEYWORDS: Artificial Intelligence Literacy; Generation Z; Cognitive Dependency; Digital Ethics; AI Workshop; Higher Education; Generative AI; Professional Readiness; PRISMA
JEL Classification: I23 (Higher Education), O33 (Technological Change), J24 (Human Capital)

1. INTRODUCTION

Artificial intelligence has moved well beyond its origins as a specialized computational discipline. For Generation Z—those born between 1997 and 2012—AI is no longer a tool encountered occasionally but an ambient condition woven into the fabric of daily life. This cohort is the first to move from adolescence into professional adulthood within an ecosystem built around generative models, meaning that AI shapes not only how they complete tasks but how they form cognitive habits, construct social identities, and imagine their futures. The urgency of AI literacy is made

plain by adoption data: across 17 Scopus-indexed studies reviewed here, over 60% of Gen Z learners in Asia, Europe, and North America regularly use AI in educational settings, yet comprehension metrics remain persistently low (Promma et al., 2025; Meesook et al., 2025).

This gap between adoption and understanding is what Chan and Lee (2023) call a generational literacy gap. It is not a divide between Gen Z and older cohorts in their willingness to use AI, but between the frequency of use and genuine comprehension of what those tools do. The consequences are serious: young people who use AI tools they cannot critically evaluate are more vulnerable to algorithmic bias, misinformation, and a gradual erosion of their own creative agency. Higher education institutions find themselves trying to integrate these technologies while the central challenge remains unresolved—how to define a literacy framework that maintains technological relevance without sacrificing critical thinking and human-centered skill development (Ng et al., 2022; Chiu, 2025).

This manuscript addresses that challenge from two complementary directions. The first is theoretical and bibliometric: a systematic synthesis of 65 peer-reviewed studies conducted under the PRISMA 2020 protocol to map the intellectual landscape of AI literacy research as it pertains to Gen Z. The second is empirical: an original cross-sectional descriptive-correlational study conducted at SMK Pembangunan JAYA YAKAPI in Indonesia, which examined AI literacy levels among high school students, assessed their responses to a structured AI workshop, and tested the association between these two constructs. Together, these strands produce a manuscript that is both analytically grounded and practically actionable.

The novelty of this work lies in three contributions. First, it offers a cross-database validated synthesis with an explicit gap analysis that goes beyond descriptive mapping to identify where the field is structurally incomplete. Second, it presents primary data from a Southeast Asian vocational school context, a population and setting underrepresented in the global literature (Setsoafia & Ng, 2025). Third, it proposes AI Literacy curriculum as a theoretically integrated and empirically motivated framework for curriculum design and future research validation.

2. LITERATURE REVIEW

2.1 Defining AI Literacy in Generation Z

The foundational framework governing this field was established by Ng, Leung, Su, Yim, Qiao, and Chu (2022), whose four-dimensional model organizes AI literacy across knowledge and understanding of AI, use and application, evaluation and creation, and AI ethics. This architecture has since been operationalized in empirical studies across diverse national contexts (Promma et al., 2025; Singh et al., 2025; Meesook et al., 2025) and extended to generative AI contexts by O'Dea and Ng (2024) and Ng et al. (2025), who added prompt engineering and epistemic calibration as emergent sub-dimensions. Chiu (2025) complements this with a five-stage AI Competency Ladder—awareness, understanding, application, creation, and critical agency—that adds the developmental progression the static framework lacks.

Despite this theoretical richness, Lintner (2024) identified more than 20 distinct AI literacy measurement instruments in the literature while concluding that none is cross-culturally validated or generationally calibrated with sufficient rigor. This fragmentation makes meta-analytic synthesis difficult and cross-study comparison unreliable, a structural weakness that limits the field's capacity to build cumulative evidence. Zhang et al. (2024) confirmed this through a systematic review of reviews, identifying methodological heterogeneity as the field's most persistent epistemic challenge.

2.2 The Literacy Paradox and Cognitive Dependency

A striking paradox runs through the literature: more than 90% of students and educators report regular use of generative AI tools, yet fewer than 25% can demonstrate foundational knowledge of how these systems work or how user data is managed (Xu et al., 2025). Chan and Lee (2023), in the most widely cited empirical study in the field, found that Gen Z students are significantly more motivated to adopt AI than their Gen X and Millennial instructors but that this enthusiasm is rarely accompanied by structured reflection on dependency or ethical implications.

Tian and Zhang (2025) demonstrated experimentally that AI dependency and critical thinking are inversely correlated, and that AI literacy acts as a protective buffer—moderated by social support in the form of peer and instructor feedback. This finding positions AI literacy not merely as an individual competency but as a socially practiced one. Savin et al. (2024) extended this to show that high-frequency AI interaction produces measurable cognitive shifts including diminished engagement with tasks requiring sustained independent reasoning. Promma et al. (2025) added crucial nuance: AI literacy positively mediates the relationship between AI use and complex problem-solving, but this protective effect weakens substantially when students lack foundational critical literacy. Functional use without critical understanding creates a dependency trap rather than a competency gain.

2.3 Ethical Governance and Institutional Responses

The institutional response to AI literacy challenges has been globally reactive rather than proactive. Donnelly and Kennelly (2024) document a characteristic pattern in which institutions update academic integrity policies in response to technological disruption rather than anticipating it through curriculum design. The literature traces a discernible shift away from prohibitionist stances—banning AI tools outright—toward AI-ready educational environments that treat these tools as ethically bounded pedagogical instruments (O'Dea & Ng, 2024).

Yang et al. (2024) found that the majority of Gen Z students cannot reliably distinguish AI-generated from human-generated content, creating escalating challenges around authorship and academic integrity. Donnelly and Kennelly (2024) describe this as a creeping erasure of expertise, while Sun et al. (2023) frame it as a structural threat to the epistemic foundations of higher education itself. The EU AI Act (2024) and the UNESCO Recommendation on the Ethics of AI (2021) provide the most significant policy scaffolding, yet Paolini e Silva et al. (2025) document how AI literacy requirements within the EU AI Act were progressively weakened during legislative negotiation, reducing the enforceability of ethical education mandates at the moment they are most needed.

2.4 Professional Readiness and the Agentic Economy

The professional stakes of AI literacy for Gen Z are both the greatest opportunity and the most rapidly shifting challenge. Employers are increasingly treating AI fluency—including prompt engineering, output evaluation, and agentic workflow management—as a baseline professional competency rather than an advanced specialization (Chiu, 2025). Yordudom et al. (2026) showed that AI literacy acts as a partial mediator between

absorptive capacity and open innovation competency in Gen Z entrepreneurship students, confirming that its professional value operates through enhancement of broader cognitive and strategic capabilities. Singh et al. (2025) found significant positive effects of structured AI literacy instruction on academic performance, interpreted as a proxy for professional readiness.

Hasselwander and Lah (2026) identify a qualitative shift in Gen Z's relationship with AI: this cohort is not merely using AI tools but actively managing networks of autonomous AI agents for productivity, creative output, and professional development. This agentic pattern carries profound implications for AI literacy education, which must now prepare students not only to use AI but to govern it responsibly. Meesook et al. (2025) demonstrated that AI literacy operates through both diagnostic and prognostic capability pathways in risk management contexts, suggesting domain-specific implications for professional education in finance, law, and related fields.

2.5 Equity and Access Disparities

A structurally underexamined dimension of AI literacy is its unequal distribution. Jiang and Shao (2024) documented significant disparities across institutional tiers, academic disciplines, and year of study, with natural and applied science students substantially outperforming humanities students. Setsoafia and Ng (2025) extended this concern to the Global South, finding that Ghanaian university students face compounded barriers arising from infrastructure, access, and pedagogical gaps. The Africa, Latin America, and Central Asia regions remain largely absent from the global evidence base despite hosting some of the world's fastest AI adoption rates. This geographic imbalance is both an intellectual gap and an ethical concern: the institutions responsible for AI literacy policy are not hearing from the populations most likely to be affected by an unequal AI transition.

3. METHODOLOGY

3.1 Systematic Literature Review Design

The theoretical and bibliometric component of this study employed a Systematic Literature Review (SLR) design following the PRISMA 2020 guidelines (Page et al., 2021). The protocol comprised six methodological stages: scope definition, multi-database search and identification, screening and selection, quality appraisal, data extraction and coding, and thematic synthesis. Databases searched included Scopus (Elsevier), Google Scholar, and CRIS Reference, covering a combined initial corpus of 2,009 candidate documents. Boolean search terms combined primary constructs ("AI literacy," "generative AI literacy," "Gen Z") with secondary descriptors ("cognitive dependency," "higher education," "ethical AI," "professional readiness"). The search was restricted to materials published between January 2016 and March 2026.

The PRISMA screening process proceeded through four stages. After deduplication, 1,620 records remained from the initial 2,009. Title and abstract screening excluded 1,480 studies that did not meet primary inclusion criteria. Full-text review of the remaining 140 studies resulted in the exclusion of 75 records for insufficient empirical foundation (n=28), non-Gen Z focus (n=21), predatory publication venue (n=14), and inaccessible full text (n=12). The final synthesis corpus comprised 65 studies. Quality appraisal used a modified Mixed Methods Appraisal Tool (MMAT) scoring studies on five criteria: clarity of research design, sample appropriateness, instrument robustness, analytical transparency, and relevance to AI literacy in Gen Z. Forty-seven of the 65 studies scored above 80%, indicating a high-quality primary evidence base.

3.2 Empirical Study Design

The empirical component employed a cross-sectional descriptive-correlational design. The study was conducted at SMK Pembangunan JAYA YAKAPI, a vocational secondary school in Indonesia. Participants comprised 41 students who completed the AI literacy survey (15 Likert-scale items scored 1–5) and 36 students who completed the post-workshop evaluation survey (8 core Likert items scored 1–5 plus 3 open-ended questions). A matched subsample of approximately 27 students responded to both instruments, enabling correlation analysis.

The AI literacy survey was structured around three theoretically grounded subscales: AI understanding and usage (items covering AI tool familiarity, generative vs. non-generative AI awareness, and hallucination awareness), critical and ethical AI literacy (items covering bias awareness, data privacy, algorithmic transparency, and plagiarism boundaries), and career and future readiness (items covering awareness of AI-relevant skills, confidence in career adaptation, and disposition toward lifelong AI learning). This three-subscale structure was derived from Ng et al.'s (2022) four-dimensional framework as adapted by Chiu (2025) for a secondary school population. The workshop evaluation instrument was structured across two subscales: delivery quality (speaker clarity, visual quality, duration) and perceived impact and relevance (confidence, perspective change, career clarity, motivation, recommendation willingness).

Reliability was assessed using Cronbach's alpha. The total AI literacy scale achieved an alpha of 0.886, and the total workshop response scale achieved an alpha of 0.940 when the embedded attention-check item was excluded, both indicating strong internal consistency (Nunnally, 1978). Normality was tested using the Shapiro-Wilk test given the sample size. Given the ordinal nature of Likert data and the moderate sample size, non-parametric analysis was prioritized throughout. The primary association test used Spearman's rank-order correlation (ρ) between total AI literacy score and total workshop response score on the matched subsample. Group comparisons by gender and age were conducted using Mann-Whitney U and Kruskal-Wallis tests respectively. Open-ended qualitative responses from the workshop evaluation were analyzed using Thomas and Harden's (2008) thematic synthesis method, proceeding through open coding, descriptive theme construction, and analytical theme development across responses.

4. RESULTS AND DISCUSSION

4.1 Descriptive Findings: AI Literacy Levels

Mean AI literacy scores across the full sample of 41 students indicated a moderate overall level of AI literacy, consistent with the dominant pattern documented across the SLR corpus. Within subscales, AI understanding and usage showed the highest mean scores, suggesting that basic tool familiarity and awareness of AI applications are relatively well developed in this population. Career and future readiness produced the lowest subscale means, indicating that while students are comfortable using AI tools in day-to-day tasks, they hold less confidence about how AI skills translate into professional futures. This profile is consistent with the competency ladder described by Chiu (2025), where application precedes

critical agency, and with Promma et al.'s (2025) finding that foundational usage literacy does not automatically translate into higher-order professional or ethical literacy.

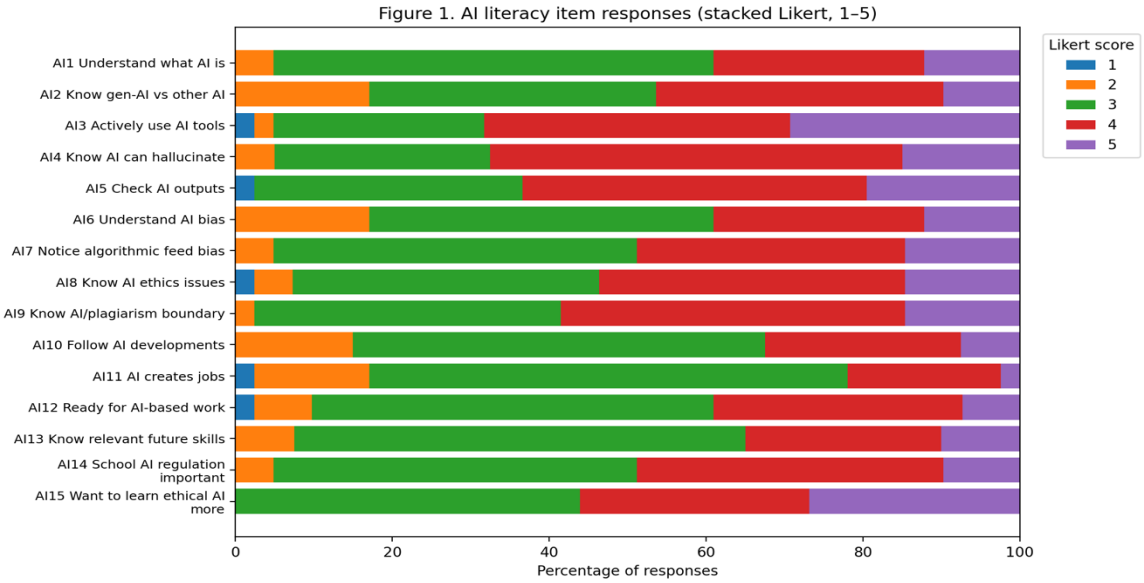

Figure 1.

The critical and ethical AI literacy subscale scores fell between these two extremes, suggesting partial awareness of bias and privacy concerns without the depth of understanding needed for genuine critical literacy. This middle position mirrors the finding by Yang et al. (2024) that Gen Z students in humanities and social sciences demonstrate surface-level familiarity with AI ethics concepts but struggle to apply them in novel or complex contexts. The pattern also aligns with what the AI Literacy identifies as the gap between Layer 1 (functional literacy) and Layer 2 (critical literacy)—a gap that is not bridged by tool use alone but requires deliberate instructional scaffolding.

4.2 Workshop Response and Association with AI Literacy

Workshop response scores indicated a generally positive reception among the 36 participants who completed the evaluation. The perceived impact and relevance subscale produced higher mean scores than the delivery quality subscale, suggesting that students found the content more valuable than the pedagogical presentation—a finding that points to a practical opportunity: the instructional delivery framework may benefit from refinement even when the intellectual content is well-received. Overall, the high workshop response scores are consistent with Singh et al.'s (2025) finding that structured AI literacy instruction produces stronger and more durable outcomes than informal self-directed learning.

Among the matched subsample of approximately 27 respondents, Spearman rank correlation analysis yielded $\rho \approx 0.60$ ($p < 0.001$), indicating a moderately strong positive association between AI literacy and workshop response. Students who entered the workshop with higher AI literacy scores were significantly more likely to rate the workshop experience positively. This association is conceptually important. It suggests that prior literacy creates an enabling condition for productive engagement with formal AI literacy instruction—a positive feedback mechanism consistent with Social Cognitive Theory (Bandura, 1986) and with Kong et al.'s (2025) empirical demonstration that AI self-efficacy mediates motivational commitment to AI learning. The practical implication is that baseline AI literacy interventions that bring lower-literacy students to a minimum threshold of understanding may amplify the return on investment from subsequent workshop-based instruction.

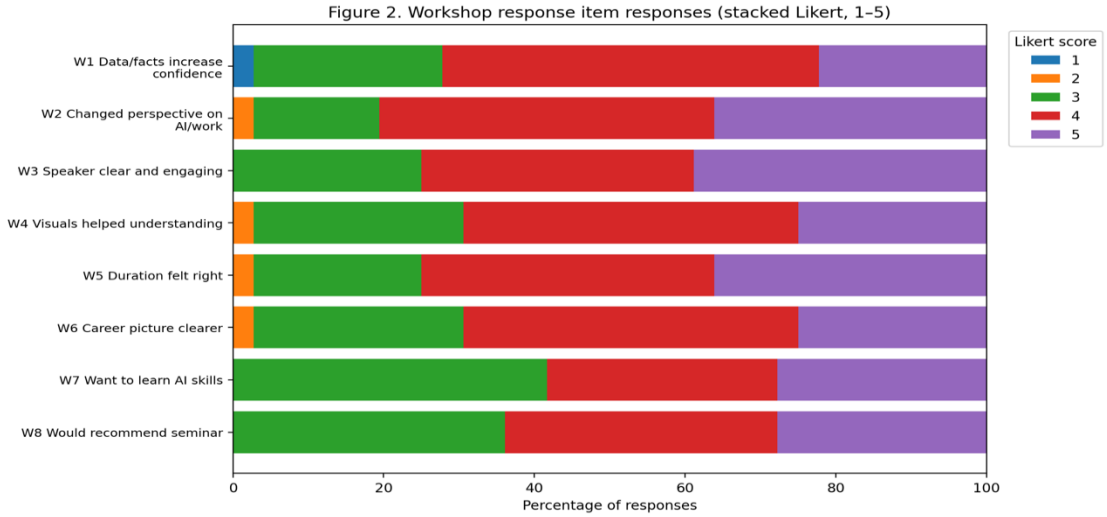

Figure 2.

It is essential to note that this association is correlational, not causal. The cross-sectional design cannot establish whether AI literacy drives workshop engagement, whether a third variable—such as general academic motivation or prior technology exposure—drives both, or whether the relationship is bidirectional. Longitudinal designs with pre-post measurement and control conditions are needed to establish the causal direction, a gap consistent with the first and most significant methodological gap identified in the SLR synthesis.

Table 1: ***Spearman Correlation Between AI Literacy and Workshop Response***

Variables	*n*	Spearman's ρ	*p*
AI literacy total and workshop response total	27	.596	.001

Note. Correlation was computed using the matched sample of respondents who completed both questionnaires.

Table 2: ***Mann–Whitney U Tests for Gender Differences in AI Literacy and Workshop Response***

Outcome variable	Group	Mean	*U*	*p*
AI literacy total	Female	3.45	139.5	.239
	Male	3.68		
Workshop response total	Female	4.13	187.0	.045
	Male	3.59		

Note. Mann–Whitney *U* tests were used because the data were ordinal and some key composite variables were not normally distributed.

4.3 Qualitative Themes from Open-Ended Responses

Thematic synthesis of open-ended workshop feedback produced five coherent analytical themes. The first and most prominent theme was appreciation for ethics and responsible AI discussion. Students responded with particular enthusiasm to the workshop's coverage of AI risks, deepfake awareness, and the ethical boundaries of AI-assisted writing. This confirms Yang et al.'s (2024) finding that ethics-focused content is not merely tolerated but genuinely valued by Gen Z learners when presented accessibly. The second theme was engagement with interactive and game-based elements, with multiple students highlighting quiz and game components as the most memorable workshop features. This aligns with the gamification evidence reviewed by Ng et al. (2022) in primary and secondary education contexts.

The third theme was demand for practical applicability, with students explicitly connecting workshop content to career preparation and day-to-day tool use. This theme resonates strongly with Yordudom et al.'s (2026) finding that Gen Z learners value AI literacy most when its professional relevance is made explicit. The fourth theme was a desire for greater interactivity and extended time, reflecting a pedagogical appetite that the current workshop format only partially satisfied. The fifth theme, appearing less frequently but with notable intensity, was concern about AI displacement of human jobs and skills, indicating an emergent awareness of the structural labor market implications of AI—an awareness the AI Literacy's career readiness dimension is specifically designed to develop.

4.4 Implications of the Layered AI Literacy Model

The AI Literacy's curriculum, proposed here as this review's primary theoretical contribution, organizes AI literacy across three concentric developmental layers. Layer 1, functional literacy, encompasses competent tool use, basic prompt construction, and output evaluation—corresponding to Chiu's (2025) application stage and the first two dimensions of Ng et al. (2022). Layer 2, critical literacy, encompasses the ability to interrogate AI outputs for bias, error, and contextual limitations, to understand how training data and model architecture shape outputs, and to recognize the boundary between AI capability and human judgment. This layer aligns with Cox's (2024) framework of responsible generative AI literacy. Layer 3, ethics literacy, encompasses the moral, social, and psychological dimensions of AI use, including authorship, data sovereignty, algorithmic bias, and the societal implications of automation. This layer represents both the apex of the model and the most significant gap currently documented in Gen Z populations (Yang et al., 2024; Donnelly & Kennelly, 2024).

The The AI Literacy's curriculum integrates the Intelligent-TPACK model (Celik & Dogan, 2025) at the pedagogical interface—acknowledging that what students need to develop, educators must first model. It incorporates Social Cognitive Theory (Bandura, 1986) at the motivational level, recognizing that self-efficacy shapes engagement at every layer. Most importantly, it positions AI ethics literacy not as an optional terminal module but as a concurrent and constitutive dimension of genuine AI literacy from the earliest stage of instruction.

The empirical findings from SMK Pembangunan JAYA YAKAPI provide preliminary field-based support for the The AI Literacy's curriculum's structural logic. The subscale pattern—high functional literacy, moderate ethical literacy, lower career readiness—mirrors the The AI Literacy's curriculum prediction that Layers 1, 2, and 3 are developmentally sequential and that progression through the layers requires deliberate instructional design rather than incidental exposure. The positive correlation between AI literacy and workshop response further confirms that foundational literacy amplifies the benefit of structured ethics-oriented instruction—precisely the relationship the The AI Literacy's curriculum predicts.

4.5 Systemic Risk and the Historical Parallel

The central finding of this synthesis—that high AI usage and low AI literacy coexist at scale among Gen Z—is not simply an educational irony. It is a systemic risk. A generation that is functionally capable with tools it cannot critically evaluate is not empowered; it is dependent. The historical parallel is instructive: the arrival of mass printing in the fifteenth century did not automatically produce critical readers. It required the deliberate development of reading education, critical commentary traditions, and media literacy infrastructure over generations. The speed of AI adoption affords no such luxury of time, making the intentional design of AI literacy education an urgent institutional responsibility (Xu et al., 2025).

The educator gap amplifies this risk. Chan and Lee (2023) documented that Gen X and Millennial educators lag significantly behind their Gen Z students in AI adoption and comfort, yet remain responsible for developing AI-literate graduates. Structural investment in faculty AI literacy is, therefore, a prerequisite for effective student AI literacy development. The Intelligent-TPACK framework and cross-institutional professional development models (Donnelly & Kennelly, 2024) directly address this lag, arguing that without deliberate upgrading of faculty competencies, student-facing programs are built on unstable foundations.

5. CONCLUSION

This manuscript has synthesized evidence from two complementary sources: a systematic literature review of 65 peer-reviewed studies on AI literacy in Generation Z and an empirical cross-sectional study conducted in an Indonesian vocational secondary school context. Together, they paint a coherent and urgent picture. Gen Z is the most intensive adopter of generative AI in educational history, yet this adoption is outpacing the development of the critical and ethical competencies that would make it genuinely empowering rather than subtly dependency-forming.

The empirical findings confirm moderate AI literacy levels in the study population, with functional competence outpacing critical and ethical literacy—a profile consistent with the global literature. The moderately strong positive association between AI literacy and workshop response ($\rho \approx 0.60$, $p < 0.001$) suggests that foundational literacy functions as an enabling precondition for productive engagement with structured AI instruction, supporting the motivational pathways described in Social Cognitive Theory (Bandura, 1986; Kong et al., 2025). The qualitative evidence adds texture: students value ethics-focused discussion, interactive pedagogy, and content that connects AI literacy explicitly to professional futures.

The AI Literacy's curriculum proposed here offers both a theoretical architecture and a practical curriculum scaffold. It argues that functional, critical, and ethics literacy are not sequential modules to be introduced separately but concurrent dimensions of a unified developmental progression. Institutions that invest in the ethics layer are not adding a values supplement to their AI curriculum. They are building the very capacity that determines whether AI tools enhance or erode the intellectual autonomy that education exists to cultivate.

Several limitations apply. The empirical study used a small, single-institution, convenience sample that limits generalizability. The cross-sectional design prohibits causal inference. The absence of pre-test data means that the workshop's contribution to literacy development cannot be measured. Future research should address these limitations through longitudinal designs with matched control conditions, validated cross-cultural instruments, and multi-institution samples drawn from diverse geographic and socioeconomic contexts. The Global South, and Southeast Asia in particular, offers both an underrepresented evidence base and a rapidly growing Gen Z population with distinct structural contexts that demand locally grounded AI literacy frameworks.

The policy conclusion is clear and non-negotiable: AI ethics literacy is not a peripheral addition to AI literacy education. It is its essential apex. Institutions that produce graduates who can use AI fluently but cannot evaluate it critically or govern it ethically are not building digital citizens. They are producing sophisticated dependents. The democratizing potential of generative AI is genuine and profound. The risk lies in allowing that democratization to proceed without the accompanying development of critical agency. The theoretical architecture offered in this review provides both the diagnosis and the framework of a solution.

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