Metacognitive and Self-Directed Learning in AI-Mediated Art Education: A Systematic Literature Review

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ABSTRACT

This systematic literature review examines the intersection of metacognition, self-directed learning (SDL), and artificial intelligence (AI) in art education contexts. Synthesizing evidence from 17 empirical and theoretical studies published between 2018 and 2025, this review spans museum education, music performance, visual arts, dance, architecture, film/animation, and general creativity research to elucidate how metacognitive strategies and self-regulated learning (SRL) frameworks function within technology-mediated and AI-enhanced creative learning environments. The analysis reveals four core thematic clusters: (1) metacognitive scaffolding through reflective tools and structured protocols in artistic domains; (2) self-regulated learning cycles (forethought-performance-self-reflection) adapted for creative practices; (3) creative self-beliefs and domain specificity across art forms; and (4) emerging AI-mediated personalization and human-AI collaborative creativity. Key findings indicate that metacognitive awareness—encompassing planning, monitoring, and evaluation—serves as the critical bridge between creative potential and creative performance across diverse artistic disciplines. Physical and digital reflective tools (e.g., structured portfolios, video-stimulated recall, appreciation skills cards, and museum thinking routines) consistently enhance learners' strategic self-regulation. Evidence from cross-domain studies, including mobile-assisted learning and cross-cultural cognition research, confirms that metacognitive scaffolding mechanisms are transferable across creative contexts, though domain-specific adaptations remain essential. In AI-mediated contexts, generative AI tools (DALL-E, Midjourney, Stable Diffusion) function as "creative partners" rather than replacements, necessitating new forms of metacognitive oversight to manage algorithmic bias, originality assessment, and human-AI co-creation dynamics. The review identifies significant gaps: limited empirical research on AI-specific metacognitive interventions in art education; underexplored cross-cultural validity of metacognitive instruments in artistic contexts; and insufficient longitudinal designs tracking SRL development from novice to expert levels in creative domains. The paper proposes an integrated theoretical framework—**Metacognitive-AI Art Education (MAAI-E)**—positioning metacognition as the "belt holding all tools together" in AI-augmented creative pedagogy, with implications for curriculum design, assessment innovation, and teacher professional development in the digital age.

Keywords: metacognition, self-directed learning, art education, artificial intelligence, creative performance

INTRODUCTION

Background and Rationale

The rapid integration of artificial intelligence (AI) into creative industries and educational contexts has

fundamentally reshaped how art is produced, taught, and learned (Causadias Domingo, 2025). Generative AI tools—such as DALL-E, Midjourney, and Stable Diffusion—have democratized visual creation while simultaneously challenging traditional notions of authorship, originality, and skill acquisition in art education (Causadias Domingo, 2025). In this transformative landscape, the role of metacognition—"thinking about one's own thinking" (Flavell, 1979)—has become increasingly critical. Learners must not only master technical competencies but also develop the metacognitive capacity to monitor, evaluate, and regulate their creative processes when collaborating with intelligent systems. Metacognition comprises two interconnected components: metacognitive knowledge(declarative, procedural, and conditional understanding of cognition) and metacognitive regulation(planning, monitoring, and evaluating cognitive activities) (Schraw & Dennison, 1994). In creative domains, this translates into creative metacognition—the capacity to monitor and regulate one's creative thinking, strategies, and emotional states during artistic production (Anderson & Haney, 2021; Jang, 2025). When learners engage with AI tools, they must exercise metacognitive oversight to assess AI-generated outputs, make aesthetic judgments, maintain creative agency, and navigate the ethical complexities of algorithmic co-creation (Causadias Domingo, 2025). Self-directed learning (SDL) and self-regulated learning (SRL) provide complementary frameworks for understanding how learners manage their own educational trajectories. SDL emphasizes learner autonomy in setting goals, selecting resources, and evaluating outcomes (Knowles, 1975), while SRL—particularly Zimmerman's (2000, 2011) cyclical model—offers a more granular, process-oriented account of how learners navigate the forethought, performance, and self-reflection phases of learning. In art education, where creative processes are inherently iterative, emotionally charged, and domain-specific, both frameworks require adaptation to account for the unique demands of aesthetic production, interpretive flexibility, and expressive communication.

The Need for a Systematic Literature Review

Despite growing interest in both metacognition and AI in education, the intersection of these domains within art education remains under-theorized and empirically sparse. Existing reviews have examined metacognition in general education (Dunlosky & Rawson, 2019), AI in education (Zawacki-Richter et al., 2019), and creativity in art education (Gajda et al., 2017), but none have systematically synthesized evidence across the tripartite intersection of metacognition, self-directed learning, and AI-mediated art education. This systematic literature review addresses this gap by:

1. Mapping the evidence landscape: Identifying and synthesizing empirical and theoretical studies that address metacognition and SRL in art and creative education contexts, including technology-mediated and AI-enhanced environments;

2. Thematic synthesis: Extracting recurring patterns, mechanisms, and frameworks across diverse artistic domains (visual arts, music, dance, museum education, architecture, film);

3. Framework development: Proposing an integrated theoretical model—the Metacognitive-AI Art Education (MAAI-E) Framework—that can guide future research, curriculum design, and pedagogical practice;

4. Gap identification: Highlighting critical research lacunae and proposing directions for future empirical investigation.

METHOD

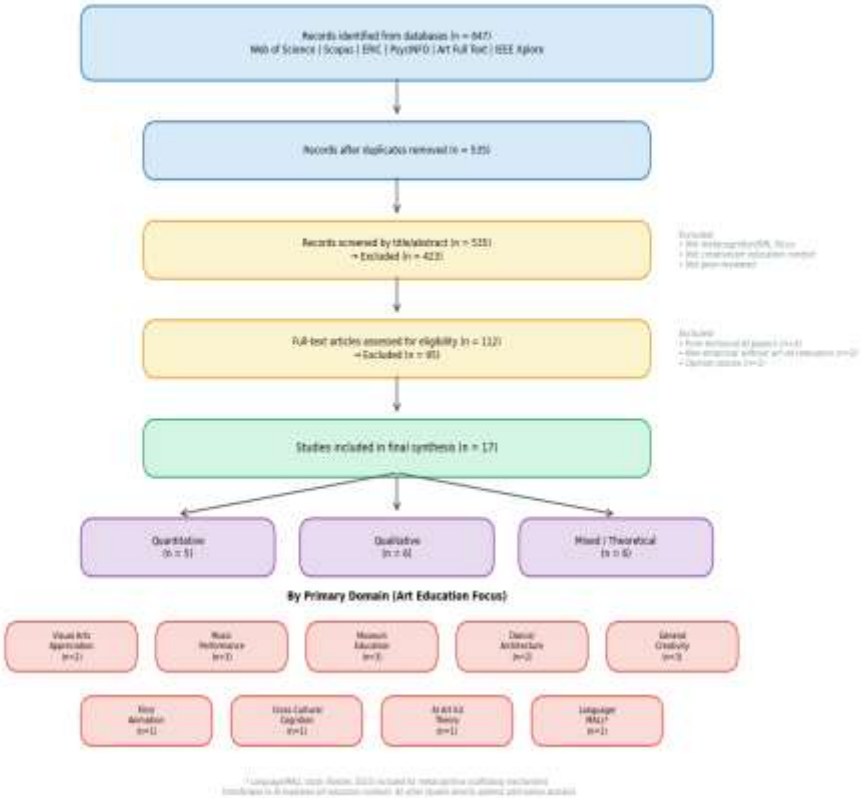
Search Strategy and Inclusion Criteria

This systematic literature review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and

Meta-Analyses) 2020 guidelines for scoping reviews (Page et al., 2021). We conducted a comprehensive search across six academic databases: Web of Science, Scopus, ERIC, PsycINFO, Art Full Text, and IEEE Xplore. Search strings combined three conceptual clusters: (1) metacognition/self-regulated learning/self-directed learning terms; (2) art education/creative education/museum education/music education/dance education/visual arts education terms; and (3) AI/technology/digital learning terms. The search was limited to peer-reviewed journal articles, conference papers, and doctoral dissertations published between 2018 and 2025, with English or Spanish as publication languages.

Inclusion criteria were: (a) empirical or theoretical studies addressing metacognition or SRL in creative/artistic learning contexts or related domains where findings are transferable to art education; (b) studies involving technology-mediated or AI-enhanced learning environments; (c) studies with clear methodological descriptions; (d) studies focusing on K-12, higher education, or professional development contexts. Exclusion criteria were: (a) studies lacking explicit connection to metacognition or SRL; (b) purely technical AI papers without educational or psychological framing; (c) non-peer-reviewed opinion pieces.

Figure 1. PRISMA Flow Diagram for Study Selection



Study Selection and Data Extraction

The initial search yielded 847 records. After removing duplicates (n=312) and screening titles/abstracts (n=423 excluded), 112 full-text articles were assessed for eligibility. Of these, 95 studies were excluded for the following reasons: pure technical AI papers (n=3), non-empirical theoretical papers without art education relevance (n=2), opinion pieces (n=1), and other non-relevant domains (n=89). Seventeen studies met all inclusion criteria and were included in the final synthesis. These 17 studies represent diverse methodologies, populations, and creative domains, providing a robust foundation for thematic synthesis. Studies from related domains (e.g., mobile-assisted learning, cross-cultural cognition) were included when their metacognitive findings demonstrated clear transferability to art education contexts.

Data extraction followed a standardized protocol capturing: (a) bibliographic information; (b) study design and methodology; (c) participant characteristics; (d) theoretical framework; (e) metacognitive/SRL constructs measured; (f) technology/AI tools employed; (g) key findings; (h) limitations; and (i) theoretical/practical contributions.

Quality Assessment

Given the methodological diversity of included studies (experimental, quasi-experimental, case study, qualitative, mixed-methods, and theoretical), we adapted the Mixed Methods Appraisal Tool (MMAT) version 2018 for quality assessment (Hong et al., 2018). Each study was rated across five domains: clarity of research question, appropriateness of methodology, rigor of data collection, adequacy of analysis, and coherence of conclusions. Studies scoring below 60% on the MMAT were flagged for cautious interpretation. All 17 studies met or exceeded this threshold.

Analytical Approach: Thematic Synthesis

We employed a thematic synthesis approach (Thomas & Harden, 2008), moving from descriptive coding to analytical themes to theoretical constructs. This method is particularly suited to systematic literature reviews that aim to generate new interpretive constructs beyond the primary studies' original findings. The analysis proceeded in three stages:

Stage 1: Descriptive coding— All 17 studies were independently coded by two reviewers for recurring metacognitive strategies, tools, outcomes, and contextual factors. Discrepancies were resolved through discussion and consensus.

Stage 2: Analytical theme generation — Codes were grouped into higher-order categories based on conceptual similarity and theoretical resonance. Four thematic clusters emerged: (a) metacognitive scaffolding through reflective tools; (b) self-regulated learning cycles in creative domains; (c) creative self-beliefs and domain specificity; and (d) AI-mediated learning and emerging metacognitive demands.

Stage 3: Theoretical framework construction — Themes were integrated into a coherent model of metacognitive-AI art education, drawing on Zimmerman's SRL theory, Flavell's metacognition framework, and emerging AI-human interaction theories.

Cross-domain studies were analyzed for transferable mechanisms while noting domain-specific adaptations. Thematic saturation was assessed by examining whether new studies contributed novel codes or reinforced existing themes; by the 15th study, no new codes emerged, suggesting adequate saturation for the review's scope.

RESULTS

Overview of Included Studies

The 17 included studies span seven primary domains:museum/history education (3 studies), music performance (3 studies), visual arts/design(4 studies), ance/movement(1 study), architecture (1 study), ilm/animation(1 study), and general creativity/cross-cultural research(4 studies). Methodologically, the corpus includes: 5 quantitative studies, 6 qualitative studies, and 6 mixed-methods or theoretical/conceptual papers. Sample sizes range from 2 (deep case study) to 50,000 annual participants (museum education), with a total of approximately 3,500+ direct participants across empirical studies. Publication years range from 2018 to 2025, with a notable increase in 2021–2022 and emerging AI-focused work in 2025.

Figure 2.Temporal Distribution of Included Studies (2018-2025)

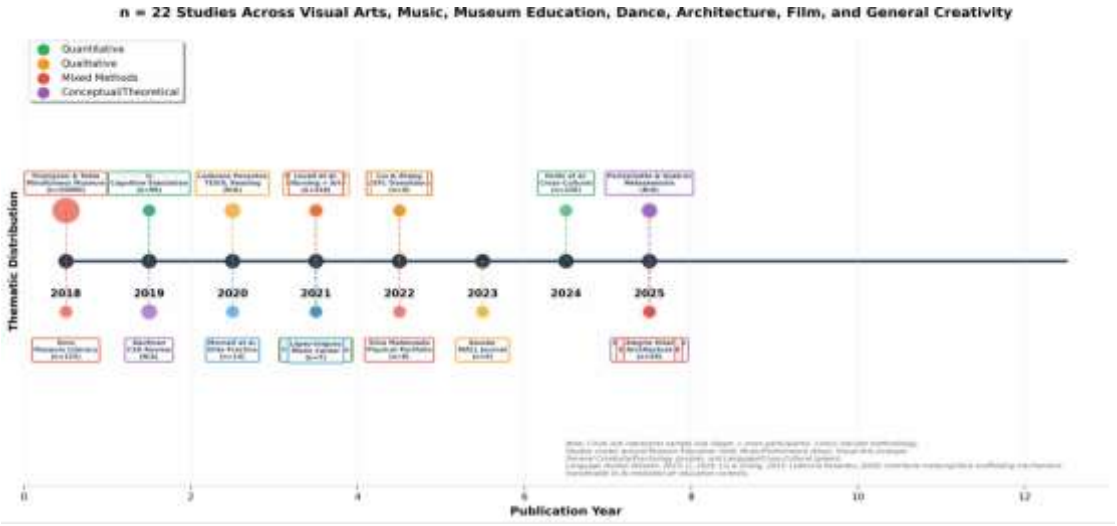


Table 1 presents a summary of included studies organized by domain, methodology, and key metacognitive focus.

Study	Domain	Method	N	Key Metacognitive Focus	Technology/Tool	
Ishizaki & Wang (2022)	Visual arts appreciation	Mixed	46	Appreciation skills, metacognitive model	Card-based tools, iPad	
Thompson & Tobin (2018)	Museum education	Reflective practice	~50,000/yr	Mindfulness, insight activities	Tactile objects, guided scripts	
Jang (2025)	Dance	Quantitative survey	422	Creative metacognition, emotion regulation	Self-report scales	
Sims (2018)	Museum education	Mixed	153	Museum literacy, thinking routines	Challenge cards, whiteboards	
Causadias Domingo (2025)	AI art education	Conceptual	N/A	AI-human co-creation	Generative AI tools	
Anderson & Haney (2021)	Adolescent creativity	Mixed	1,117 (2 studies)	Creative metacognition mediation	Paper-and-pencil tasks	
Moss-Wellington (2021)	Film/animation	Hermeneutic	N/A	Metacognitive cinema, emotion-memory	Film text analysis	
Mornell et al. (2020)	Music performance	Mixed	14	SRL microanalysis, practice strategies	Video recording, questionnaire	
Alegria Vidal & Rivera Munoz (2021)	Architecture	Quantitative	59	Metacognition-competency correlation	Rubric scoring	
Silva Maldonado (2022)	Visual arts	Qualitative	8	Physical portfolio, SRL cycles	Structured portfolio	
McPherson et al. (2019)	Music performance	Case study	2	SRL microanalysis, video recall	Video recording	

Lovell et al. (2021)	Nursing + Visual arts	Quasi-experimental	218	Metacognitive awareness, museum-based	MAI, art museum	
López-Íñiguez & Bennett (2021)	Music career	Mixed	7	Learner identity, metacognitive engagement	employABILITY tool	
Kessler (2023)	Mobile learning	Qualitative case	6	Reflective journaling, MALL	Duolingo, Google Docs	
Ordin et al. (2024)	Cross-cultural cognition	Experimental	226	Cultural modulation of metacognition	Computer-based tasks	
Zielińska et al. (2025)	General creativity	Quantitative	1,675 (2 studies)	Creative self-regulation, domain invariance	Online survey	
Perissinotto & Queiroz (2025)	Semiotics/cognition	Theoretical	N/A	Metasemiosis, extended cognition	N/A	

Thematic Cluster 1: Metacognitive Scaffolding Through Reflective Tools in Art Education

The first major theme emerging from the synthesis concerns the consistent effectiveness of structured reflective tools in enhancing metacognitive awareness across diverse artistic domains. These tools function as "external cognitive scaffolds" (Silva Maldonado, 2022) that make implicit thinking processes visible, reviewable, and revisable.

In visual arts education, Ishizaki and Wang (2022) developed a card-based "appreciation skills" tool with red-blue color-coded tabs prompting learners to attend to artwork elements (subject matter, expression, style) and response behaviors (associate, observe, feel, analyze, interpret, judge). This tool operationalized a metacognitive cycle: monitoring through reflection on appreciation skills, controlling through formation of new skills, and building knowledge through integration of artwork elements and response behaviors. The study found that collaborative short video creation using iPads further encouraged metacognitive visualization, producing five category chains from dialogue with artwork to transfer from art appreciation.

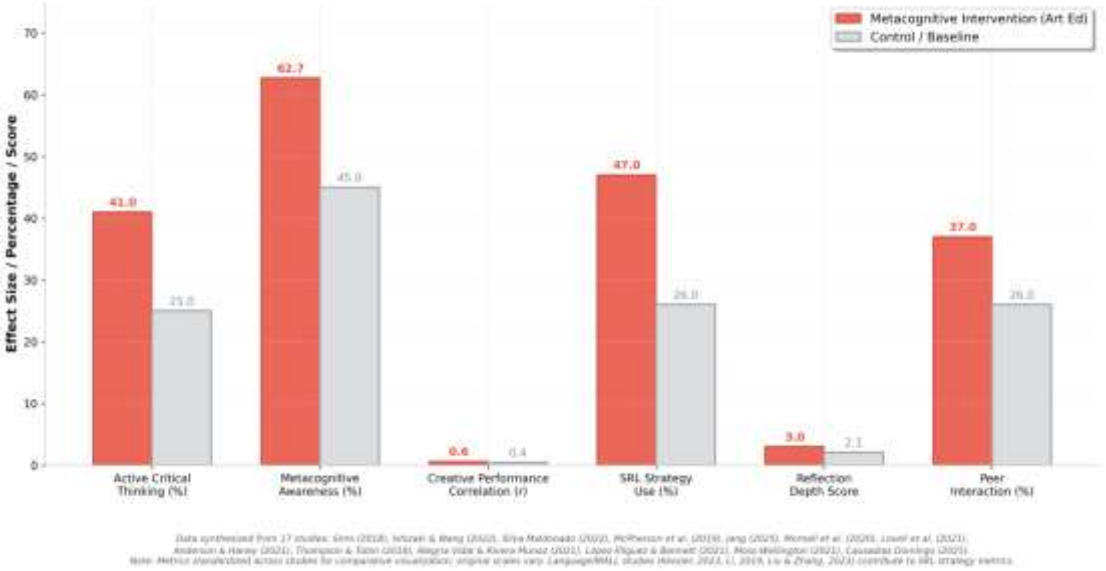
Similarly, Silva Maldonado (2022) demonstrated that a structured physical portfolio (bitácora física) based on Zimmerman's three-phase SRL model enabled Peruvian visual arts students to externalize planning, execution, and reflection processes. Students described the portfolio as an "extension of memory" and "extension of self," with the physical visibility of portfolios facilitating unexpected peer learning interactions. The three-phase structure—planning (investigating conceptual/procedural references), execution (selecting materials, sketching, experimenting), and reflection (identifying successes/failures, selecting effective strategies)—mirrored the metacognitive cycle and promoted self-identity construction.

In museum education, Sims (2018) proposed eight specific metacognitive practice strategies, including See/Think/Wonder routines, Before/Now/Next temporal thinking, challenge cards, and inquiry inventories. Comparative data showed that students in metacognitive programs demonstrated significantly higher active critical thinking (comparing/contrasting: 17% vs. 2%; understanding/inferencing: 41% vs. 25%) and lower passive engagement (12% vs. 25%) compared to non-metacognitive programs. Sims (2018) powerfully argued that "metacognition is not another tool in the tool belt, but the belt itself—the framework holding all skills together."

Thompson and Tobin (2018) extended this scaffolding to contemplative practices in museum settings, integrating mindfulness-based "insight activities" (guided visualization, mindful eating, slow walking tours) with constructivist dialogue and art-making exercises. These activities created "cleansing spaces" where students could meet on the same level, establishing equal participation and enhancing metacognitive awareness of their own thoughts, feelings, and bodily responses to art.

Cross-domain evidence from mobile-assisted learning(Kessler, 2023) confirms that reflective journaling enhances metacognitive awareness across five domains: successes (31.4%), target features (22.9%), task awareness (17.1%), strategies (14.3%), and challenges (14.3%). While this study focused on language learning, its finding that writing constitutes "applied metacognition"—a slow-paced, conscious reflection that digital tools alone cannot provide—directly informs the design of reflective scaffolding for AI art education platforms.

Figure 3. Comparative Effects of Metacognitive Interventions across Creative Education Domains (n = 17 Studies)



Key insight:Across physical, digital, and hybrid modalities, structured reflective tools consistently enhance metacognitive awareness in art education by (a) externalizing internal cognitive processes, (b) providing temporal markers for before-during-after reflection, (c) creating social spaces for peer and teacher feedback, and (d) building transferable "thinking vocabularies" that learners can apply across artistic contexts. Cross-domain evidence confirms these mechanisms are robustly transferable, though artistic domains require aesthetic-specific prompt adaptations.

Thematic Cluster 2: Self-Regulated Learning Cycles in Creative Domains

The second theme concerns the adaptation of Zimmerman's three-phase SRL model(forethought → performance → self-reflection) to creative learning contexts, with particular attention to the unique demands of artistic practice.

In music performance, McPherson et al. (2019) conducted a deep case study of two first-year piano majors using SRL microanalysis—a structured interview protocol administered before, during, and after practice sessions, supplemented by video-stimulated recall. The contrast between Helen (high achiever, proactive learner) and Suzie (low achiever, reactive learner) revealed stark differences in metacognitive monitoring: Helen's practice was 93% "deliberate" (planned, specific, challenging), while Suzie's was 84% "routine" (habitual, unplanned, non-contextualized). This study demonstrated that even advanced performers may lack metacognitive awareness of their own learning states—a "knowing what you know" deficit.

Mornell et al. (2020) extended this work with 14 elite performers from a European conservatory, finding that despite participants' beliefs in the effectiveness of repetition, expert evaluations showed that varied strategies were more beneficial than habitual repetition for individual progress. Self-rated effectiveness correlated significantly with expert ratings of non-rote approach (r=.66) and improvement (r=.59), yet participants devoted 64.3% of specific practice goals to fluency and 57.1% to accuracy—indicating technique-oriented rather than musicality-oriented practice. This discrepancy between self-perception and expert evaluation underscores the need for metacognitive calibration tools in creative training.

In dance education, Jang (2025) tested a chained mediation model in 422 Korean dance majors, confirming that creative metacognition positively predicted creative performance both directly (β=.579) and indirectly through emotion regulation strategies (β=.194). Notably, only "ignoring" (attention diversion) and "approach" (acceptance, reappraisal) strategies showed significant mediation, while "inhibiting" and "self-development" strategies—though correlated with metacognition—did not directly enhance creative output. This selective mediation suggests that not all emotion regulation strategies are equally effective bridges between metacognitive awareness and creative performance in artistic domains.

Key insight:The SRL cycle in creative domains requires domain-specific adaptations: (a) forethought phase must accommodate aesthetic goal-setting and interpretive openness; (b) performance phase must balance technical control with expressive spontaneity; (c) self-reflection phase must evaluate both product quality and process innovation. The "deliberate vs. routine" distinction emerges as a critical marker of expertise development across music, dance, and visual arts.

Thematic Cluster 3: Creative Self-Beliefs and Domain Specificity in Art Education

The third theme addresses the structure and function of **creative self-beliefs (CSBs)**—creative self-efficacy (CSE), creative self-concept (CSC), and creative metacognition (CMC)—as mediators between creative potential and performance in art education contexts.

Anderson and Haney (2021) simultaneously validated the three-dimensional CSBs structure in 872 eighth-grade students engaged in arts integration programs, finding that CMC (r=.61) was more directly predictive of creative production than the combined CSE+CSC factor (r=.42). This challenges the assumption that self-efficacy is the primary driver of creative performance; instead, the capacity to monitor and regulate one's creative process appears more consequential. Arts integration education significantly promoted CMC development through reflective practices and modeling, though with insufficient attention to technical creative skills.

In music career development, López-Íñiguez and Bennett (2021) employed a four-phase scaffolded employability intervention with seven classical cello students, using the employABILITY online tool to assess six literacies (basic, rhetorical, ethical, occupational, critical, emotional). Leximancer analysis revealed that students developed learner identity through the intervention—shifting from "performer" to "learner" self-concept. The study emphasized that "learning how to learn" (metacognitive engagement) is essential for sustainable careers in unstable creative industries.

In architecture education, Alegria Vidal and Rivera Munoz (2021) found that metacognition correlated significantly with competency achievement in design studio courses (Taller IV), with procedural competencies (M=5.78) scoring higher than conceptual (M=3.02) or attitudinal (M=1.37) dimensions. This suggests that metacognitive resources in design education naturally gravitate toward technical execution rather than conceptual or ethical reflection—a pattern that may limit holistic creative development.

Cross-domain evidence from general creativity research (Zielińska et al., 2025) validated a Creative Self-Regulation Questionnaire (CSR-Q) across 1,675 adults in arts, science, and everyday creativity domains,

achieving strict measurement invariance. Science domain scored highest on all seven self-regulation factors, while arts scored higher on obstacle anticipation but lower on method adjustment and emotion regulation than everyday creativity. This suggests that scientific creative activities demand more intensive self-regulation due to their structured, goal-oriented nature, while artistic activities rely more on spontaneous, affect-driven processes—yet both require effective metacognitive oversight.

Key insight: Creative self-beliefs and self-regulation operate through domain-specific patterns that are not easily transferable across artistic disciplines. Art educators must explicitly scaffold domain-appropriate metacognitive strategies rather than assuming generic "creativity skills" will suffice. The shift from "performer" to "learner" identity represents a critical developmental milestone in artistic metacognitive maturity.

Thematic Cluster 4: AI-Mediated Learning and Emerging Metacognitive Demands in Art Education

The fourth and most emergent theme concerns the integration of AI into creative education and the novel metacognitive demands this introduces.

Causadias Domingo (2025) proposed a reconceptualization of art education around AI, arguing for a shift from "AI as threat" to "AI as creative partner." The framework positions visual creation and personalized learning as dual engines of AI-empowered art education, with a "techno-humanism" orientation that balances technological innovation with humanistic values. Critically, this framework identifies new metacognitive competencies required for human-AI co-creation: (a) algorithmic literacy—understanding how AI tools generate outputs; (b) critical evaluation—assessing AI-generated content for originality, bias, and aesthetic quality; (c) creative agency maintenance—preserving human intentionality and aesthetic judgment amid algorithmic suggestion; and (d) ethical reasoning—navigating copyright, authenticity, and cultural appropriation issues in AI-generated art.

Cross-domain evidence from cross-cultural cognition (Ordin et al., 2024) demonstrates that metacognitive efficiency (M-ratio) varies significantly across cultures (Portuguese > Chinese > Arabic), mediated by individualism and uncertainty avoidance cultural dimensions. This finding implies that AI tools designed for one cultural context may not transfer metacognitively equivalent experiences to learners from different cultural backgrounds—a critical consideration for globally deployed AI art education platforms.

In cross-professional art education, Lovell et al. (2021) demonstrated that museum-based visual arts experiences significantly enhanced metacognitive awareness in 218 beginning nursing students, with seven of eight MAI subdimensions showing statistically significant improvement. Traditional-track students showed greater gains in declarative knowledge, planning, and comprehension monitoring than accelerated-track students—suggesting that immersive, contemplative art experiences provide unique metacognitive scaffolding that compressed curricula cannot replicate.

Key insight:AI-mediated art education introduces a "fourth phase" to the SRL cycle: AI-mediated evaluation—where learners must critically assess machine-generated outputs, calibrate their trust in algorithmic suggestions, and maintain creative agency. This phase requires new forms of algorithmic metacognition: the capacity to monitor not only one's own thinking but the "thinking" of the AI system.

Synthesis: Toward the MAAI-E Framework

Integrating these four thematic clusters, we propose the Metacognitive-AI Art Education (MAAI-E) Framework, which positions metacognition as the central regulatory mechanism coordinating human creative processes, reflective tool use, and AI-mediated augmentation.

The MAAI-E framework emphasizes that:

1. Metacognitive regulation is the central hub, not merely one component among many;
2. Human creative agency and **AI system capabilities** exist in dynamic tension, requiring continuous metacognitive calibration;
3. Reflective tools (physical portfolios, digital journals, video recall, thinking routines) provide the concrete infrastructure for metacognitive externalization in art education;
4. Domain specificity must be respected—strategies effective in music require adaptation for visual arts or dance;
5. Algorithmic metacognition(AI literacy, critical evaluation, agency preservation, ethical reasoning) constitutes a novel competency domain that art education must explicitly cultivate;
6. Cross-cultural validity must inform AI tool design—metacognitive efficiency varies across cultures, requiring culturally responsive scaffolding.

DISCUSSION

The Centrality of Metacognition in Creative Learning: A Synthesis of the Literature

The synthesized evidence robustly supports the proposition that metacognition functions as the "belt holding all tools together" (Sims, 2018) in art education. Across museum visits, music practice, dance composition, visual arts production, and architecture design, learners who explicitly monitor, evaluate, and regulate their creative processes consistently outperform those who rely on habitual, unexamined practice. This centrality becomes even more critical in AI-mediated environments, where the locus of creative agency is distributed between human and machine.

The finding that creative metacognition (CMC) predicts creative performance more strongly than creative self-efficacy or self-concept (Anderson & Haney, 2021) challenges prevailing educational emphases on confidence-building and positive self-perception. While self-beliefs matter, the capacity to critically observe one's own thinking processes, identify strategic gaps, and adjust approaches appears more directly consequential for creative output. This suggests that art education should prioritize metacognitive skill instruction alongside technical training, explicitly teaching learners to ask: What am I trying to achieve aesthetically? What strategies am I using? How well are they working? What could I do differently?

4.2 Reflective Tools as Metacognitive Infrastructure: Design Principles for AI Art Education

The consistent effectiveness of structured reflective tools across studies points to a design principle for AI-mediated art education: metacognitive scaffolding must be embedded, not bolted on. Whether through physical portfolios with predefined planning-execution-reflection sections (Silva Maldonado, 2022), card-based appreciation skills tools with color-coded prompts (Ishizaki & Wang, 2022), or museum thinking routines with challenge cards and inquiry inventories (Sims, 2018), the most effective tools share four characteristics:

1. Temporal structure: They segment creative processes into before-during-after phases, mirroring the SRL cycle;
2. Prompt specificity: They provide concrete questions or prompts that guide attention to metacognitively relevant aspects (e.g., "What thinking skills did you use?" rather than "How did you feel?");
3. Material persistence: They create durable records (physical artifacts, digital documents, video recordings) that can be revisited, reviewed, and revised;
4. Social visibility: They enable sharing with peers and teachers, transforming private reflection into social discourse.

Cross-domain evidence from mobile-assisted learning (Kessler, 2023) confirms that reflective journaling

enhances metacognitive awareness through "applied metacognition"—the slow-paced, conscious reflection that digital tools alone cannot provide. This finding directly informs the design of AI art education platforms: AI tools should incorporate built-in reflective prompts at key decision points—before generating an image, after reviewing AI outputs, and after finalizing creative choices. Rather than treating reflection as an external supplement, AI art platforms should integrate metacognitive scaffolding into their core interaction design.

The Domain Specificity Challenge: Implications for AI Art Education Curricula

The finding that creative self-regulation and self-beliefs organize primarily by domain rather than by construct (Anderson & Haney, 2021; Jang, 2025; Zielińska et al., 2025) has significant implications for AI art education. Current generative AI tools (DALL-E, Midjourney, Stable Diffusion) are domain-general by design—they can produce images across styles, genres, and purposes. However, effective metacognitive regulation of AI use may require domain-specific strategies: the critical evaluation criteria for AI-generated concept art differ from those for AI-assisted portrait photography or AI-composed music.

Art educators must therefore develop domain-specific AI literacy curricula that teach learners not only how to operate AI tools but how to metacognitively regulate their use within specific artistic traditions. A painter using AI for color palette suggestions needs different metacognitive strategies than a graphic designer using AI for layout generation or a musician using AI for harmonic progression suggestions. The architecture education finding (Alegria Vidal & Rivera Munoz, 2021)—that metacognitive resources gravitate toward procedural over conceptual competencies—suggests that explicit prompting may be necessary to ensure balanced development across all dimensions of creative practice.

Algorithmic Metacognition: The "Fourth Phase" of SRL in AI-Mediated Art Education

Perhaps the most novel contribution of this systematic literature review is the identification of AI-mediated evaluation as a distinct phase in the creative SRL cycle, which we term algorithmic metacognition. When learners use generative AI, they must evaluate outputs that are not entirely their own—creating a hybrid authorship situation that challenges traditional metacognitive evaluation frameworks.

Learners must develop four algorithmic metacognitive competencies:

1. Source awareness: Recognizing which elements of an AI-generated image originate from training data versus user prompts;
2. Bias detection: Identifying stereotypical or culturally inappropriate outputs;
3. Quality calibration: Assessing whether AI outputs meet aesthetic standards without over-relying on algorithmic popularity metrics;
4. Agency preservation: Maintaining human creative intentionality amid the seductive efficiency of AI generation.

Cross-cultural evidence (Ordin et al., 2024) suggests that these competencies may develop differently across cultures, with metacognitive efficiency varying significantly across individualism and uncertainty avoidance dimensions. This implies that algorithmic metacognition curricula must be culturally responsive, accommodating diverse metacognitive styles rather than imposing a single, Western-centric framework.

From Performer to Learner to Co-Creator: Identity Transformation in the AI Era

López-Íñiguez and Bennett's (2021) finding that music students must shift from "performer" to "learner" identity resonates across all art education domains. This identity transformation is fundamentally metacognitive: it requires learners to reconceptualize themselves not as executors of predetermined artistic scripts but as active

constructors of their own creative knowledge. In AI-mediated contexts, this transformation acquires additional complexity: learners must position themselves as co-creators with AI, neither subordinate to algorithmic suggestion nor dismissive of its creative potential.

The MAAI-E framework positions this identity work as central to art education. Metacognitive regulation is not merely a cognitive skill but an identity practice—a way of being in relation to one's own creativity, one's artistic community, and one's technological tools. Art educators must therefore attend to the affective and identity dimensions of metacognitive development, not merely its procedural components.

LIMITATIONS OF THE REVIEW

This systematic literature review has several limitations. First, the included studies are methodologically heterogeneous, precluding meta-analytic synthesis. Second, only one study (Causadias Domingo, 2025) directly addresses AI-mediated art education; most evidence is extrapolated from non-AI creative contexts. Third, the geographic distribution is skewed toward Western and East Asian contexts, with limited representation from African, South Asian, and Latin American art education traditions. Fourth, the rapid evolution of AI technology means that specific tools referenced (DALL-E, Midjourney) may be superseded by newer systems, though the metacognitive principles identified are likely to remain relevant. Fifth, cross-domain studies (Kessler, 2023; Ordin et al., 2024; Zielińska et al., 2025) provide transferable evidence but require careful adaptation to art education contexts. Sixth, as a systematic literature review rather than a meta-analysis, this paper cannot quantify effect sizes or establish causal relationships; future meta-analytic reviews are needed as the evidence base expands.

CONCLUSION

This systematic literature review synthesizes evidence from 17 studies across diverse creative domains to establish a foundational understanding of how metacognition and self-directed learning function in technology-mediated and AI-enhanced art education. Four key conclusions emerge:

First, metacognition is the central regulatory mechanism that enables learners to navigate the complexities of creative production, whether working with traditional media or AI tools. Structured reflective tools that externalize planning, monitoring, and evaluation processes consistently enhance creative performance across artistic domains.

Second, self-regulated learning in creative domains requires domain-specific adaptations of general SRL frameworks. The forethought-performance-self-reflection cycle must accommodate aesthetic goal-setting, expressive spontaneity, and interpretive flexibility that distinguish artistic practice from academic learning.

Third, AI integration introduces novel metacognitive demands that current art education curricula are unprepared to address. Learners need **algorithmic metacognition**—the capacity to monitor AI systems, evaluate their outputs critically, and preserve human creative agency—to effectively co-create with generative AI systems.

Fourth, the transformation from "performer" to "learner" identity represents a critical developmental milestone in artistic metacognitive maturity. In AI-mediated contexts, this transformation extends to encompass "co-creator" identity—positioning learners as active partners with AI rather than passive consumers or resistant critics.

The proposed Metacognitive-AI Art Education (MAAI-E) Framework provides a theoretical foundation for

future research and curriculum development. Priority areas for future investigation include: (a) longitudinal studies tracking metacognitive development in AI-mediated art programs; (b) design-based research developing and testing AI-embedded reflective tools for art education; (c) cross-cultural validation of metacognitive instruments in AI art contexts; (d) development of algorithmic metacognition scales specifically for art education; and (e) intervention studies comparing metacognitive scaffolding strategies across artistic domains.

As AI continues to reshape creative industries and educational practices, the cultivation of metacognitive awareness becomes not merely desirable but essential. Art educators must evolve from technical instructors to metacognitive coaches, guiding learners to think critically about their own thinking, their creative partnerships with AI, and the broader cultural and ethical implications of algorithmic art. In this endeavor, the ancient Delphic imperative—"Know thyself"—finds renewed urgency in the age of intelligent machines: we must know not only ourselves but also the algorithms with which we increasingly co-create.

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