Swami Vivekananda Advanced Journal for Research and Studies
Online Copy of Document Available on: www.svajrs.com

ISSN:2584-105X **Pg. 338-344**

CREATIVE, CRITICAL THINKING AND PROBLEM SOLVING IN EDUCATION

Abhay Kumar Pandey
M.Ed (University of Allahabad)
Email: pandeyabhay749@gmail.com

Accepted: 21/12/2024
Published: 27/12/2024 ***DOI: http://doi.org/10.5281/zenodo.17497567***

Abstract

Across the global education landscape, the development of creative thinking, critical thinking, and problem-solving abilities has become an imperative for twenty-first-century learners. These cognitive competencies underpin innovation, democratic participation, and lifelong learning in an increasingly complex and unpredictable world. This paper provides a comprehensive review of theoretical frameworks, empirical findings, and instructional models related to these three interconnected constructs. It examines the conceptual evolution of critical thinking as reflective judgment, creative thinking as the generation of novel and contextually appropriate ideas, and problem solving as the application of knowledge and reasoning to resolve ill-structured tasks. Drawing on meta-analytic evidence, cross-national assessments, and design-based pedagogies, the review argues that these skills are not innate but teachable and measurable through deliberate curriculum design, authentic assessment, and reflective pedagogy. It concludes with an integrated model for developing thinking competencies in formal education, emphasizing teacher preparation, learning environment design, and equity-oriented policy support.

Keywords: *Critical thinking, creative thinking, problem solving, higher-order cognition, metacognition, twenty-first-century skills, reflective judgment, innovation in education, inquiry-based learning, curriculum design, learning assessment, equity and inclusion.*

1. Introduction

The twenty-first century has redefined the purposes of education, shifting the focus from rote memorization and knowledge acquisition toward fostering complex cognitive and metacognitive abilities that enable learners to navigate uncertainty, ambiguity, and change. Globalization, automation, and digitalization have intensified the demand for individuals who can think creatively, analyze critically, and solve problems collaboratively. As articulated in the **UNESCO Futures of Education Report (2021)**, the goal of modern education systems is not merely to transmit information but to cultivate the intellectual autonomy, imagination, and ethical reasoning necessary for human flourishing in a rapidly transforming world (UNESCO, 2021).

1.1 Rationale and Context

Educational discourse has long emphasized "thinking" as the highest goal of schooling. However, the current context is distinguished by a new urgency. As knowledge becomes more fluid and information more abundant, students must be equipped not simply to recall facts but to interpret, evaluate, and reconfigure them for novel purposes. **Critical thinking** ensures discernment amid misinformation; **creative thinking** drives innovation and adaptability; and **problem solving** bridges the two, enabling application of ideas to real-world challenges (Facione, 1990; Amabile, 2012; Hmelo-Silver, 2007). Together, these capacities represent what scholars call "higher-order thinking skills" (HOTS) abilities that extend beyond comprehension to evaluation, synthesis, and creation (Bloom, 1956; Anderson & Krathwohl, 2001).

In global policy frameworks such as the **OECD Learning Compass 2030** and **UNESCO's Sustainable Development Goal 4 (Quality Education)**, these competencies are positioned as foundational for personal agency and civic participation (OECD, 2024; UNESCO, 2021). They underpin innovation-driven economies and democratic societies alike, linking educational outcomes to national development. For instance, employers consistently rank critical thinking, creativity, and complex problem-solving among the top skills required for the future workforce (World Economic Forum, 2023).

1.2 Theoretical Foundations

Each construct has evolved from distinct intellectual traditions. **Critical thinking**, rooted in philosophical inquiry, emerged from Socratic questioning and pragmatist epistemology, later operationalized through the American Philosophical Association's Delphi study, which defined it as "purposeful, self-regulatory judgment" (Facione, 1990). This definition underscores both **cognitive skills** analysis, inference, evaluation and **dispositional traits** such as open-mindedness, fairness, and intellectual humility (Facione, 2013; Paul & Elder, 2006). It bridges epistemic virtue and cognitive psychology, linking thinking quality to metacognitive regulation and reflective judgment (Kuhn, 1999).

Creative thinking, conversely, derives from psychology and the arts. The **Componential Model of Creativity** (Amabile, 2012) conceptualizes creativity as a function of domain-relevant skills, creative-thinking strategies, and intrinsic motivation. Torrance's (1966) early psychometric approach sought to measure divergent thinking through fluency, flexibility, and originality, while later developmental frameworks such as the **Four-C Model** (Kaufman & Beghetto, 2009) situate creativity along a continuum from mini-c (personal insights) to Big-C (eminent creativity) relevant to educational practice.

Problem solving, the third dimension, has its roots in mathematical heuristics and cognitive science. Pólya's (1945/1957) seminal work *How to Solve It* articulated a four-step model: understanding the problem, devising a plan, executing the plan, and reflecting on the solution. Modern constructivist interpretations integrate this with inquiry learning and design thinking, emphasizing iterative experimentation, collaboration, and reflection (Hmelo-Silver, 2007; Jonassen, 2011). In educational terms, problem solving represents the application and synthesis of both creative idea generation and critical evaluation.

1.3 Integration and Interdependence

Though often treated separately in policy and curriculum frameworks, creative, critical, and problem-solving skills are **mutually interdependent**. Critical thinking refines and evaluates creative ideas, ensuring logical coherence and ethical soundness. Creative thinking, in turn, expands the scope of critical inquiry by generating alternative perspectives and innovative hypotheses. Problem solving serves as the contextual bridge where creative ideation and critical evaluation converge to produce practical outcomes (Scott et al., 2004; Hmelo-Silver, 2007). Empirical studies confirm that instruction integrating all three dimensions yields stronger transfer effects than when they are taught in isolation (Abrami et al., 2015).

For example, in science education, inquiry-based learning requires students to hypothesize (creative), test and interpret evidence (critical), and design solutions (problem solving). Similarly, in the humanities, debate and essay writing involve generating original arguments (creative), assessing evidence and logic (critical), and organizing coherent responses (problem solving). The integration of these dimensions therefore lies at the heart of **deep learning**, as described by Marton and Säljö (1976), in which students seek meaning and application rather than superficial recall.

1.4 Empirical and Policy Evidence

Over four decades of research underscore that these competencies can be **explicitly taught and reliably assessed**. Meta-analyses by **Abrami et al. (2008; 2015)** demonstrated consistent positive effects (Hedges g ≈ .30–.34) for instructional interventions in critical thinking, especially when explicit reasoning strategies, modeling, and feedback are embedded in coursework. Similarly, **Scott, Leritz, and Mumford (2004)** reported medium-to-large effects for structured creativity training programs teaching process stages such as idea generation, elaboration, and evaluation. In problem-based learning contexts, **Strobel and van Barneveld (2009)** and **Walker and Leary (2009)** found that students in PBL environments achieved superior long-term retention and transfer compared to traditional lecture settings.

These findings have informed national reforms. The **OECD's Programme for International Student Assessment (PISA) 2022** introduced a *Creative Thinking* domain, operationalizing it through tasks that measure originality, diversity, and quality of ideas across written, visual, and scientific contexts. Results highlighted both feasibility and inequity: socio-economic status strongly predicted performance, underscoring the need for equity-oriented implementation (OECD, 2024). Concurrently, many education systems, including those in Singapore, Finland, and Australia, have embedded creative and critical thinking as transversal competencies across curricula (Lucas & Spencer, 2017).

1.5 Pedagogical Implications

Despite policy consensus, effective classroom implementation remains uneven. Research warns against assuming that creative and critical thinking naturally emerge from content instruction. Rather, they require **explicit teaching, guided practice, and reflective feedback** (Facione, 2013; Dwyer et al., 2011). Teachers must model thinking processes, make reasoning visible, and design open-ended tasks that balance structure with autonomy. A meta-analysis by Dwyer, Hogan, and Stewart (2011) on argument mapping found that visualizing reasoning processes significantly enhanced students' critical thinking performance. Likewise, creative pedagogy research emphasizes autonomy-supportive environments, authentic audiences, and assessment criteria valuing originality and appropriateness over conformity (Amabile, 2012).

The rise of **digital learning environments** from online collaboration tools to simulation-based labs adds new possibilities and complexities. Technology can support divergent thinking through idea-generation platforms, enable iterative feedback through analytics, and scaffold inquiry through adaptive tutoring. Yet, as OECD (2024) cautions, the promise of digital tools must be matched with teacher capacity-building and ethical governance to ensure inclusion and fairness.

1.6 Purpose of the Review

Given this intellectual and policy backdrop, this review paper seeks to synthesize the theoretical, empirical, and practical dimensions of creative, critical thinking, and problem-solving education. Specifically, it aims to:

1. Trace the conceptual evolution and definitional clarity of each construct.
2. Examine empirical evidence on effective pedagogical strategies and measurable learning outcomes.
3. Explore integrative frameworks linking creativity, criticality, and problem solving in contemporary curricula.
4. Discuss implications for teacher education, assessment reform, and policy coherence in promoting higher-order thinking at scale.

By interweaving philosophical foundations, psychological evidence, and policy directions, this paper argues that fostering these competencies is not an "add-on" but the **core mission of education in a knowledge society**. Developing learners who can generate ideas, reason soundly, and act ethically is essential to sustaining innovation, democracy, and human progress.

2. Conceptualizing the Constructs

2.1 Critical Thinking

A widely accepted definition, emerging from a Delphi panel of 46 experts convened by the American Philosophical Association, frames critical thinking as "purposeful, self-regulatory judgment" yielding interpretation, analysis, evaluation, and inference, plus explanation of evidential, conceptual, methodological, or contextual considerations (Facione, 1990). It distinguishes **skills** from **dispositions** the latter including open-mindedness, inquisitiveness, systematicity, and confidence in reason which are necessary for appropriate application of skills in real tasks (Facione, 1990; Facione, 2013). Parallel practitioner-oriented frameworks e.g., Paul and Elder's elements of thought and intellectual standards translate these constructs into instructional heuristics (clarity, accuracy, depth, breadth, logic) used for course design and assessment rubrics (Paul & Elder, 2006). Developmental accounts emphasize the growth of metacognitive, metastrategic, and epistemological understanding as foundations for sophisticated reasoning (Kuhn, 1999).

2.2 Creative Thinking

Creativity is commonly defined as the production of ideas or artifacts that are **novel** and **appropriate** to task and context (Amabile, 2012). The **Componential Theory of Creativity** posits that domain-relevant skills, creativity-relevant processes (e.g., ideational flexibility), task motivation, and the social-organizational environment interact to influence creative performance (Amabile, 2012). The **Four-C model** extends the traditional Big-C/Little-C distinction by adding **mini-c** (personally meaningful insights) and **Pro-c** (professional-level creativity short of eminent Big-C), providing a developmental lens for education (Kaufman & Beghetto, 2009). Psychometric traditions often rely on the **Torrance Tests of Creative Thinking (TTCT)**, with longitudinal and renorming debates; Kim (2011) famously reported declines in TTCT scores for U.S. schoolchildren post-1980s, sparking a "creativity crisis" discussion and renewed attention to schooling environments (Kim, 2011; see also contemporary validity reviews).

2.3 Problem Solving

Classical work by Pólya (1945/1957) conceptualized problem solving as a heuristic cycle: understand the problem, devise a plan, carry out the plan, and look back (reflection). Contemporary inquiry and **problem-based learning (PBL)** extend these heuristics into collaborative, ill-structured domains where learners engage with authentic problems, externalize reasoning, and iteratively test solutions under guidance (Hmelo-Silver, 2007; Strobel & van Barneveld, 2009; Walker & Leary, 2009). These approaches foreground metacognition (planning, monitoring, evaluating) and epistemic cognition (what counts as evidence) as levers for transfer.

3. Measurement and Assessment

3.1 Assessing Critical Thinking

Assessment practices include standardized tests aligned to the Delphi skills (e.g., analysis, inference) and rubric-based evaluations of discipline-embedded tasks. The importance of **dispositions** complicates measurement: students may possess skills but fail to deploy them without motivational and epistemic triggers (Facione, 1990). Developmental perspectives suggest assessing metacognitive and epistemological dimensions (Kuhn, 1999), while **argument-mapping** approaches provide visible traces of reasoning structure amenable to formative feedback and have been linked to gains in critical thinking (Dwyer et al., 2011; van Gelder, 2015 summary).

3.2 Assessing Creative Thinking

The TTCT remains a widely used instrument for divergent thinking (fluency, flexibility, originality, elaboration). Kim (2011) reported declining norms, prompting debates about environmental constraints on creativity; more recent reviews discuss differential validity of figural vs verbal forms and cross-cultural use (Alabbasi, 2022). System-level assessment milestones include **PISA 2022 Creative Thinking**, operationalizing idea generation, evaluation and improvement across multiple domains with open-ended tasks and analytic rubrics; results report socio-economic gradients and within-country variability, raising equity concerns (OECD, 2024).

3.3 Assessing Problem Solving

Problem solving is frequently assessed with ill-structured tasks requiring explanation of strategy, justification of assumptions, and reflection on outcomes often in domains like science inquiry or engineering design. PBL assessment typically blends product (solution quality) and process (collaboration, inquiry cycles) with performance-based rubrics; meta-syntheses note tensions between near-term recall outcomes and long-term retention transfer measures (Strobel & van Barneveld, 2009; Walker & Leary, 2009).

4. What Works? Evidence on Teaching for Thinking

4.1 Critical Thinking Instruction

Two major syntheses indicate that **explicit instruction** combined with **practice and feedback** produces small-to-moderate positive effects on critical thinking. A stage-1 meta-analysis across 117 studies (N≈20,698) reported a mean effect size $g^{+}≈.34$ (Abrami et al., 2008). Subsequent reviews that distinguished skills and dispositions and coded instructional moderators similarly reported mean effects around .30, with stronger results for stand-alone CT courses or for infused approaches that make reasoning criteria explicit (Abrami et al., 2015). Interventions emphasizing **argument mapping** show promising gains by making reasoning structures visible and improvable (Dwyer et al., 2011; Butchart et al., 2009). Cognitive strategy training that strengthens retrieval practice and spaced practice indirectly supports CT by deepening knowledge accessible to reasoning (Dunlosky et al., 2013).

4.2 Creativity Interventions

Meta-analytic evidence demonstrates that **well-designed creativity training** especially programs teaching creative process steps and critical/creative thinking strategies yields robust improvements on creativity measures, particularly when practice, domain relevance, and explicit strategy instruction are included (Scott et al., 2004; 2004b). Classroom design features consistent with the **Componential Theory** autonomy, task value, authentic constraints, and supportive evaluation climates enhance intrinsic motivation and creative performance (Amabile, 2012). At system level, **PISA 2022** demonstrates feasibility of assessing creative thinking and reveals predictable socio-economic gradients, suggesting that school-level climate and resources remain critical moderators (OECD, 2024).

4.3 Problem-Based and Inquiry-Based Learning

A meta-synthesis of meta-analyses found **PBL superior** to conventional instruction for **long-term retention, skill development, and learner/teacher satisfaction**, though conventional methods sometimes produce higher **short-term recall** on standardized tests (Strobel & van Barneveld, 2009). A complementary meta-analysis showed that outcomes vary by **problem type, implementation design, discipline, and assessment level**, emphasizing the need for scaffolding and alignment (Walker & Leary, 2009). Reviews of inquiry/scaffolding suggest that **guided** inquiry (not minimally guided) is most effective, especially when cognitive load is managed and strategies are modeled (Hmelo-Silver, 2007).

5. Intersections: How the Three Constructs Reinforce Each Other

The constructs are analytically distinct yet mutually reinforcing. **Critical thinking** provides evaluative standards (relevance, sufficiency, coherence) that improve the **quality of creative ideas** by filtering out weak or ungrounded proposals (Facione, 1990; Paul & Elder, 2006). **Creative thinking** expands the **option space** for problem solving by increasing ideational fluency and flexibility (Amabile, 2012; Scott et al., 2004). **Problem solving** offers the authentic, ill-structured contexts in which creative ideation and critical evaluation are exercised and integrated, building transfer through cycles of planning, monitoring, and reflection (Pólya, 1945/1957; Hmelo-Silver, 2007). This synergy is evident in design-based courses where students must articulate claims with evidence (critical), propose multiple designs (creative), and iteratively test under constraints (problem solving).

6. Designing for Impact: Principles and Practices

6.1 Make Reasoning Visible and Formative

Argument mapping and structured reasoning tasks make premises, conclusions, and inferential links explicit, enabling targeted feedback and self-correction. Randomized and quasi-experimental studies report significant gains when students engage in repeated mapping with feedback (Dwyer et al., 2011; van Gelder, 2015; Butchart et al., 2009). Embedding **retrieval practice and spacing** improves knowledge availability, which is a prerequisite for sophisticated reasoning about domain problems (Dunlosky et al., 2013).

6.2 Teach Creative Processes, Not Just "Be Creative"

Effective creativity programs (meta-analytic evidence) provide **explicit strategy instruction** e.g., problem framing, analogical transfer, perspective taking paired with **guided practice** on authentic tasks and **feedback** (Scott et al., 2004; 2004b). Classroom climates that support **autonomy** and **task value** (e.g., student choice in topics, meaningful audiences) foster intrinsic motivation, a central driver in Amabile's model (Amabile, 2012).

6.3 Use Problems Worth Solving and Scaffold the Journey

In PBL/inquiry, problems should be **ill-structured yet tractable**, with **scaffolds** that model strategies, distribute cognitive load, and gradually release responsibility. Meta-syntheses show better outcomes when coaching is systematic and alignment among problem, process, and assessment is strong (Strobel & van Barneveld, 2009; Walker & Leary, 2009; Hmelo-Silver, 2007). Reflection phases ("look back") consolidate learning and support transfer (Pólya, 1945/1957).

6.4 Assess What Matters: Performance, Process, and Growth

Rubrics should articulate: (a) criteria for idea quality (originality, feasibility, ethicality), (b) reasoning standards (accuracy, sufficiency of evidence), and (c) problem-solving processes (planning, monitoring, revision). System-level options include **PISA-style open tasks** with analytical scoring and attention to fairness across groups; school-level options include portfolios and argument maps with periodic calibration (OECD, 2024; Dwyer et al., 2011).

7. Equity, Context, and Scaling

7.1 Opportunity Structures and Outcome Gaps

PISA 2022 reports **socio-economic gradients** in creative thinking performance across OECD systems, mirroring patterns in core domains and underscoring the role of school resources and learning climates (OECD, 2024). Equity-oriented design must include **access to rich tasks**, **teacher professional learning**, and **assessment accommodations** that fairly capture divergent and evaluative thinking. Where TTCT-based debates suggest declines or group disparities, interpretive caution is warranted: validity varies by form, language, and culture, and creative potential may be under-realized in constrained classroom climates (Kim, 2011; Alabbasi, 2022).

7.2 Teacher Expertise and Professional Learning

Instructional effects are larger when teachers explicitly teach reasoning criteria, creative strategies, and problem-solving heuristics, rather than assuming they will emerge implicitly (Abrami et al., 2015; Hmelo-Silver, 2007). Professional development should therefore blend **content knowledge** (e.g., statistical reasoning in science), **pedagogical content knowledge** (how students commonly err), and **instructional routines** (e.g., claims-evidence-reasoning; critique-revise cycles) with opportunities to analyze student work and calibrate rubrics.

7.3 Institutional and Policy Supports

At system level, **coherence** among curriculum standards, classroom assessments, and high-stakes exams is crucial to avoid wash-out effects. International guidance on curriculum/assessment modernization emphasizes **transparency of constructs**, **teacher assessment literacy**, and **attention to fairness** in high-impact decisions (OECD, 2024). Where creative/critical thinking are strategic goals, investments in **task banks**, **scorer training**, and **moderation systems** help maintain reliability while honoring the open-ended nature of tasks.

8. Open Questions and Research Agenda

Despite considerable progress, several questions remain:

Causal mechanisms and dosage. Meta-analyses demonstrate average positive effects, yet more **causal studies** are needed to isolate mechanisms (e.g., how much deliberate practice of argument mapping is necessary to sustain gains across domains?) and to track **maintenance and transfer**. **Longitudinal** designs linking classroom practices to later academic and employment outcomes are under-supplied (Abrami et al., 2008; 2015).

Assessment validity across cultures and languages. TTCT research and PISA's new creative thinking measures raise construct and fairness questions when tasks cross linguistic and cultural contexts; expanding multi-method assessment (portfolios, performances) with strong rater moderation is a priority (Kim, 2011; OECD, 2024).

Balancing guidance and discovery. Inquiry/PBL effectiveness depends on **guided** scaffolds; the field needs fine-grained studies comparing alternative scaffolding regimes (worked examples, faded guidance, prompts) by learner prior knowledge and task complexity (Hmelo-Silver, 2007; Walker & Leary, 2009).

Embedding motivational design. Amabile's model and creativity training meta-analyses highlight task motivation; how best to design **autonomy-supportive** classrooms at scale within accountability systems remains an applied research need (Amabile, 2012; Scott et al., 2004).

Digital environments and data use. As digital tools collect rich telemetry, there is opportunity to **instrument** open-ended reasoning and creativity processes (e.g., version histories, idea diversity metrics). Ensuring validity, privacy, and instructional usefulness of such analytics is an emerging line of work tied to broader debates on educational data governance. (This review's scope centers on pedagogy; readers may consult complementary analytics literature for implementation guidance.)

9. Conclusion

Creative thinking, critical thinking, and problem solving are mutually reinforcing competencies that can be **cultivated** through intentional pedagogy. The most persuasive evidence favors approaches that (a) **make thinking visible** through explicit criteria and representations (e.g., argument maps), (b) **offer guided practice** on authentic tasks with timely feedback, and (c) **assess for process and product**, combining analytic rubrics with performance evidence. Creativity flourishes under autonomy-supportive, value-rich conditions; critical thinking advances when reasoning standards are taught and practiced; problem solving develops when learners iteratively plan, test, and reflect in ill-structured contexts. System-level assessments such as PISA 2022 confirm feasibility while highlighting persistent equity gaps. Future work should connect classroom design to durable outcomes, refine culturally responsive assessment, and scale professional learning that equips teachers to orchestrate these complex forms of learning. When curriculum, pedagogy, and assessment are aligned, schools can reliably move from rhetoric about "twenty-first-century skills" to measurable gains in generative, judicious, and resilient thinkers.

References (APA 7th)

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A. C., Surkes, M., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research, 78*(4), 1102–1134.

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research, 85*(2), 275–314.

Alabbasi, A. M. A. (2022). What do educators need to know about the Torrance Tests of Creative Thinking? *Education Sciences, 12*(11), 761.

Amabile, T. M. (2012). *Componential theory of creativity* (Harvard Business School Working Paper No. 12-096). Harvard University.

Butchart, S., et al. (2009). Improving critical thinking using web-based argument mapping exercises with automated feedback. *Australasian Journal of Educational Technology, 25*(2), 268–291.

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, 14*(1), 4–58.

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2011). The promotion of critical thinking skills through argument mapping. In *Critical thinking* (pp. 1–18). Dublin: NAIRTL.

Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction (The Delphi Report).* American Philosophical Association.

Facione, P. A. (2013). *Critical thinking: What it is and why it counts* (2013 update). Insight Assessment.

Hmelo-Silver, C. E. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99–107.

Kaufman, J. C., & Beghetto, R. A. (2009). Beyond Big and Little: The Four-C model of creativity. *Review of General Psychology, 13*(1), 1–12.

Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal, 23*(4), 285–295.

Kuhn, D. (1999). A developmental model of critical thinking. *Educational Researcher, 28*(2), 16–26.

OECD. (2024). *PISA 2022 Results (Volume III): Creative thinking.* OECD Publishing.

Paul, R., & Elder, L. (2006). *The miniature guide to critical thinking: Concepts and tools* (Rev. ed.). Foundation for Critical Thinking.

Pólya, G. (1957). *How to solve it* (2nd ed.). Princeton University Press. (Original work published 1945).

Scott, G., Leritz, L. E., & Mumford, M. D. (2004a). The effectiveness of creativity training: A quantitative review. *Creativity Research Journal, 16*(4), 361–388.

Scott, G., Leritz, L. E., & Mumford, M. D. (2004b). Types of creativity training: Approaches and their effectiveness. *Journal of Creative Behavior, 38*(3), 149–179.

Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning, 3*(1), 44–58.

Walker, A., & Leary, H. (2009). A problem-based learning meta-analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdisciplinary Journal of Problem-Based Learning, 3*(1), 12–43.

van Gelder, T. (2015). Using argument mapping to improve critical thinking skills. ThinkerAnalytix (overview paper).

****