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Learning Media and Models for Critical Thinking in Indonesian Science Education: A Systematic Review of Research Trends (2019–2024)

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Abstract
Analyzing current trends in science education reveals that efforts to elevate Critical Thinking Skills frequently integrate specific science learning topics alongside targeted Learning Models and Learning Media. Within this academic domain, students must move beyond mere conceptual mastery to cultivate advanced cognitive capacities, specifically analytical reasoning. Methodologically, this investigation utilized a systematic literature review supported by content analysis, harvesting peer-reviewed papers released from 2019 through 2024. Initial screening captured 200 documents, which narrowed down to 20 final publications after rigorous inclusion filtering (Prasetyo, B. and Wahyuni, 2022). Empirical results indicate that senior high school settings dominate domestic investigations regarding cognitive advancement within science learning frameworks. Physics emerges as the predominant disciplinary focus across these publications, constituting 54% of the evaluated literature. Digital platform utilization highlights Edmodo as the primary medium, recording a usage rate of 16.8%. Furthermore, discovery learning functions as the primary pedagogical framework, driving 60% of documented interventions aimed at bolstering Critical Thinking Skills. Academic contributions of this review manifest through the consolidation of contemporary data regarding effective pedagogical strategies, offering practical guidance for educators, investigators, and syllabus designers when choosing appropriate learning models and media to cultivate cognitive proficiency.

Keywords: Critical Thinking Skills; Learning Media; Learning Model; Science Learning

1. Introduction

Engaging in Science Learning involves mastering foundational theories and structured analytical thinking to discover and build scientific concepts coupled with Critical Thinking. Throughout the educational journey within this discipline, learners must grasp academic knowledge while simultaneously cultivating advanced cognitive abilities, prominently Critical Thinking (Wahono et al., 2022). This objective aligns directly with Regulation No. 22 of 2020

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issued by the Minister of Education and Culture regarding the strategic blueprint for 2020 through 2024, which establishes the Pancasila Student Profile where analytical capability serves as a core pillar. Supporting domestic educational goals focused on building cognitive proficiency, Science Learning mandates students to strengthen these mental capacities to properly master core scientific principles (Fadlina et al., 2021)

Cultivating Critical Thinking Skills represents a disciplined intellectual practice forged through active conceptualization during the execution, examination, selection, and appraisal of data gathered via analytical reasoning (Santoso et al., 2023) Developing these proficiencies is vital across every educational stage, as they cultivate logical, systematic, rigorous, and unbiased reasoning for everyday application (Ariani, 2020) Consistently exercising these cognitive patterns nurtures a thorough, rational, and objective mindset among learners.

Fostering Critical Thinking Skills within Science Learning requires appropriate Learning Models and Learning Media to facilitate educational delivery. Effective pedagogical frameworks must remain active, innovative, creative, effective, and engaging (Festiyed et al., 2019). Selecting a suitable approach demands careful evaluation of subject matter characteristics to successfully capture student interest. Proper alignment between course content and instructional goals allows educators to efficiently drive learning outcomes while encouraging active student participation. Furthermore, an ideal framework reinforces Critical Thinking Skills by prompting students to dissect, appraise, and resolve problems tied to the curriculum. Therefore, matching instructional designs with course materials guarantees that Science Learning stays impactful and capable of stimulating advanced cognitive processing (Prasetyo & Kristin, 2020). Implementing a context-specific pedagogical framework remains indispensable for boosting student performance in this area.

While choosing a fitting framework is crucial for elevating Critical Thinking Skills, deploying effective Learning Media is equally vital. Integrating proper tools boosts learner involvement, simplifies comprehension, and encourages advanced cognitive engagement. In contrast, suboptimal performance in cognitive tasks often stems from utilizing traditional, non-

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interactive tools that fail to stimulate active participation. Consequently, adopting contemporary and contextually aligned educational tools is necessary to meaningfully advance Critical Thinking Skills (Fauziah Idris & Suhendi, 2023). Interactive platforms serve as a viable alternative for establishing dynamic instruction focused on cognitive growth (Illahi, 2018), marking them as foundational elements within Science Learning.

Prior investigations have similarly explored Critical Thinking Skills within domestic settings. Previous reviews analyzing these competencies relied on papers published between 2018 and 2023 utilizing reciprocal teaching strategies (Nurropidah & Kosmajadi, 2024), whereas scoping assessments by (Febril & Alberida, 2023) focused on peer-reviewed articles from 2018 through 2022 employing Problem-Based Learning. Additional scoping work by (Sulaiman & Azizah, 2020)) examined interventional and observational studies across higher education institutions from 2008 to 2018 using grey literature alongside bilingual formats. Building upon these foundations, the current review introduces a distinct scope by evaluating literature published between 2019 and 2024 sourced exclusively from Sinta 3 accredited or Scopus indexed outlets, thereby mapping the precise landscape of cognitive research within domestic Science Learning.

Tabel 1. Details of the Research Question (RQ) to help gather relevant information, including

RQ 1	What is the most dominant level of education in improving critical thinking skills in Indonesia (2019-2024)?
RQ 2	What are the most dominant materials used in improving critical thinking skills in Indonesia (2019-2024)?
RQ 3	What is the most dominant learning medium used to improve critical thinking skills in science (Physics, Chemistry, Biology) learning in Indonesia (2019-2024)?
RQ 4	What is the most frequently used learning model for improving critical thinking skills in science learning (Physics, Chemistry, and Biology) from 2019 to 2024?

2. Review Method

2.1. Research Design

Utilizing a Systematic Literature Review methodology underpinned by content analysis, this research investigates academic papers released from 2019 to 2024 focusing on curricular

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subjects, Learning Models, and Learning Media designed to bolster Critical Thinking Skills. Implementing this structured review technique is vital for executing a methodical and rigorous consolidation of prior findings. Broadly speaking, this methodological framework functions to condense and refine earlier data collections, subsequently enabling a more targeted and substantive evaluation of existing empirical evidence.

2.2. Population and Sampling

The initial dataset comprised 200 papers, which subsequently underwent multiple filtering phases to yield 20 finalized documents fulfilling all inclusion benchmarks. These chosen studies concentrated on educational disciplines, instructional content, Learning Media, and Learning Models applied toward advancing Critical Thinking Skills between 2019 and 2024, retrieved across Google Scholar, Sinta, Science direct, and Scopus repositories. Literature discovery relied upon specific search terms including learning media, learning model, critical thinking, physics, biology, chemistry, and science.

2.3. Data Collection Tools

The methodological workflow for this review incorporates article filtration protocols aligned with the PRISMA guidelines, guaranteeing an open, methodical, and reproducible system for discovering, screening, and finalizing target publications. Sequential review phases encompass:

2.3.1. Data selection

Inclusion parameters were established initially to guarantee that retrieved documents matched study goals and satisfied requisite standards, followed by comprehensive database screening across Google Scholar, Sinta, Science direct, and Scopus repositories to extract relevant, high-tier research publications.

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Table 2. Inclusion and Exclusion Criteria

It	Category	Inclusion Criteria	Exclusion Criteria
1	Publication Type	Articles published in journals	Articles published in conference proceedings, books, websites or blogs, etc.
2	Journal Specifications	National journals are at least accredited by Sinta 3 and international journals indexed by Scopus	The included articles consisted of national journals accredited by SINTA 4 to SINTA 6, as well as international journals not indexed in Scopus, with publication years prior to 2019
3	Year of Publication	2019-2024	Less than 2019
4	Background of the research	Indonesian	Abroad
5	Research Nationality	Indonesian, collaboration between Indonesians and foreigners	Foreigners only
6	Independent variables	Critical thinking	Not critical thinking
7	Field	Science (Chemistry, Physics, Biology)	Beyond natural science
8	Research Subject	Informal education for students and teachers includes early childhood education, elementary school, junior high school, high school, vocational school, and university	Students and teachers in non-formal schools or special needs schools

Manuscript filtering and reduction relied upon preset inclusion benchmarks, leaving twenty qualified papers that underwent detailed evaluation via abstract assessments and full-text reading.

2.3.2. The coding instrument was constructed to satisfy rigorous standards of validity and reliability. Parameters embedded within the coding framework encompassed journal titles, publishing houses, participant education tiers, indexing databases, and publication serial numbers. Following extraction, the gathered datasets underwent evaluation through percentage-based computations.

2.3.3. Document trends emerged from the analytical results, mapping out recurring curriculum subjects alongside Learning Media and Learning Models frequently

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deployed to elevate Critical Thinking Skills. These identified regularities were subsequently consolidated to resolve the core research objectives, as illustrated in Figure 1.

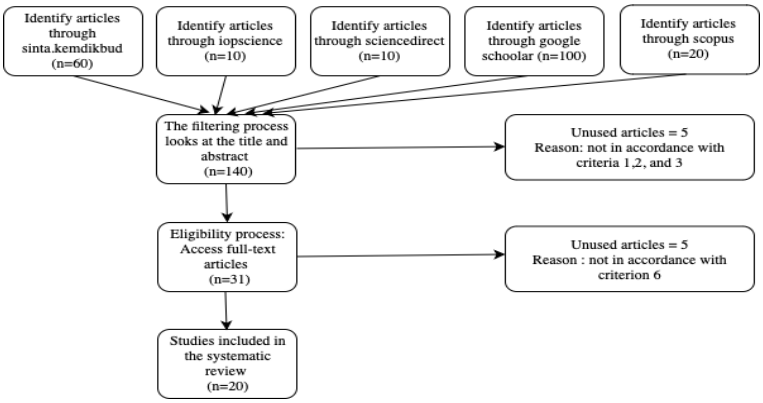

Figure 1. Article selection procedure flowchart

3. Findings and Discussion

3.1. Data Selection

During the retrieval phase, 171 records were excluded for failing to satisfy the established parameters. Subsequent screening filtered the publications to ascertain their direct correlation with the primary inquiry, resulting in 20 papers being finalized for the main review. Specifically, this final collection comprises 15 documents sourced from Sinta and 5 extracted from Scopus repositories.

These twenty papers were chosen according to specific filtering benchmarks, requiring full-text journal accessibility, indexation in at least Sinta 3 or Scopus, publication dates spanning from 2019 to 2024, and explicit focus on recurring curriculum subjects, Learning Models, and Learning Media designed to bolster Critical Thinking Skills. A detailed inventory of these eligible publications is provided in Table 3, along with their respective coding instruments.

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Table 3. Coding instruments

Journal Type	Index	Journal Name	Sum	Percentage (%)
National	Sinta 1	-	-	-
	Sinta 2	Indonesian Journal of Science Education	2	10
		Pedagogy: Journal of Educational Sciences	1	5
		Coil physics journal	1	5
		Journal of Physics and Technology Education (JPFT)	1	5
		Journal of physics education (jpf)	1	5
		Undiksha pgsd pulpit	1	5
		Indonesian Journal of Physics Education	1	5
	Sinta 3	Bioscientist scientific journal of biology	1	5
		Elementary school journal	1	5
		Journal of education and learning	1	5
		Journal of Education and Culture	1	5
		Coil physics journal	1	5
		Edu Sains : Journal of Science and Mathematics Education	1	5
		Dwija Scholars: Journal of Pedagogic Research	1	5
International	Q2	Ijet : International Journal of Emerging Technologies in Learning	1	5
	Q3	Ijim: International Journal of Interactive Mobile Technologies	1	5
	Q4	*Journal of Physics: Conference Series (JPCS)*	3	15

3.2. Identify article patterns

This analytical phase elaborates upon and addresses the previously formulated research questions. Resolving these inquiries involves a comprehensive evaluation of the twenty selected papers compiled through strict inclusion parameters.

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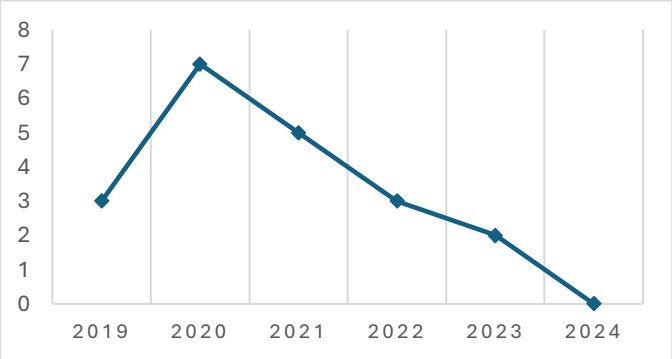

Graph 1. Article Distribution Based on Year of Publication

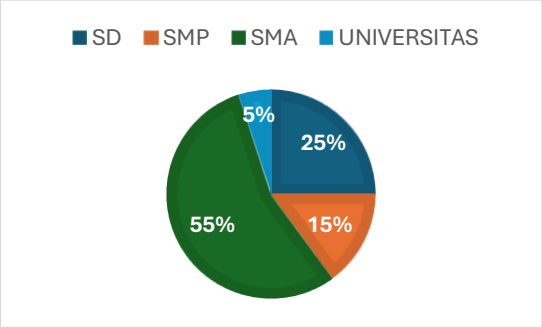

Diagram 1. Distribution of Articles Based on Education Level

Table 4. Article Distribution Based on Science Learning Materials

Science Learning Materials	Percentage
Motion System	10%
Excretion System	5%
Immune System	5%
Quantities and Units	5%
Motion Dynamics	5%
Vector and Straight Motion	5%
Environmental Pollution	5%
Energy and Its Uses	5%
Objects of the Sky, Day, Night, and Weather	5%
The Concept of Temperature, Heat, and Its Displacement	25%
Concepts and Principles of Physics	5%
The Law of Conservation of Momentum and Collision	5%
Redox Reaction	5%
Classification of Materials and Their Changes	5%
Natural Vegetative	5%

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Diagram 2. Distribution of Articles Based on the Scope of Science Learning (Physics, Chemistry, Biology)

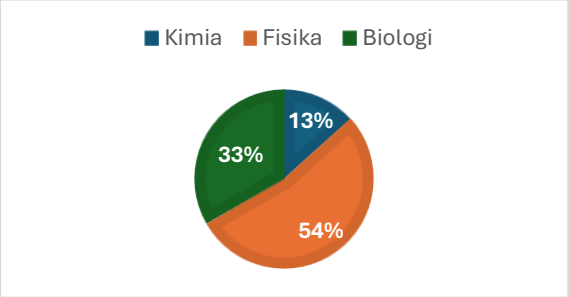

Table 5. Distribution of Articles Based on Learning Media

Learning Media	Percentage
Module	12,6%
E-Module	4,2%
LKPD (Student Worksheet)	21%
Moodle	4,2%
Flash	4,2%
Power Point	4,2%
Learning Videos	4,2%
Animated Videos	4,2%
Book	4,2%
Games	4,2%
Edmodo	16,8%
Android	4,2%
E-handout	4,2%
Visual	4,2%
Videoscribe	4,2%

Table 6. Article Distribution Based on Learning Model

Learning Model	Percentage
Discovery Learning	60%
Guided Inquiry	15%
Blended Learning	10%
Problem Based Learning	15%

3.3. Discussion

3.3.1. RQ 1: What is the most dominant level of education in improving critical thinking skills in Indonesia (2019-2024)?

Based on the Ministry of Education and Culture Regulation No. 81A of 2013, instructional activities serve as a structured framework granting learners space to nurture their

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inherent capabilities. Furthermore, Ministry Regulation No. 20 of 2013 mandates that every institutional alumnus exhibit proficiency across attitudinal, cognitive, and skill dimensions. Within the skill sector, students must cultivate creative, productive, critical, independent, collaborative, and communicative capacities by applying a scientific approach (Permata & Suyana, 2019), making Critical Thinking Skills fundamentally crucial during educational delivery.

Synthesized literature data indicates that senior high school education represents the primary tier investigated for cognitive enhancement within domestic contexts. Specifically, 55 percent of evaluated studies target senior high schools, whereas elementary, junior high, and university levels account for 25 percent, 15 percent, and 5 percent respectively.

Human beings possess an innate disposition and capacity for cognition. (Ormord, 2009) notes that Critical Thinking Skills develop progressively from early childhood through adolescence. Senior high school pupils typically fall into the adolescent demographic who have attained Piaget's final cognitive phase known as formal operational thinking (Fatihah et al., 2020). During this developmental milestone, adolescents should process abstract concepts and navigate intricate dilemmas, empowering them to evaluate alternative resolutions and foresee their outcomes. Young individuals who refine these analytical abilities display an enhanced capacity to identify personal potential and resolve real-world challenges (Novianti, 2020). .

3.3.2. What is the most dominant learning medium used to improve critical thinking skills in science (Physics, Chemistry, Biology) learning in Indonesia (2019-2024)?

Derived from the systematic review outcomes, physics emerged as the primary scientific discipline applied to elevate Critical Thinking Skills within Science Learning, representing 54 percent of analyzed literature. National curriculum guidelines mandate that students cultivate specific competencies following instructional completion, encompassing favorable dispositions alongside critical, creative, innovative, and collaborative reasoning, coupled with integrity and transparency for practical application (Ministry of Education and Culture, 2016).

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Consequently, mastering physics demands that learners maintain robust Critical Thinking Skills (Rajagukguk & Rambe, 2022)

Analytical proficiency serves as an indispensable component within physics instruction, empowering students to comprehend and interpret natural phenomena more effectively. These cognitive capacities directly shape academic competence, conceptual understanding, and instructional efficacy. Furthermore, analytical reasoning aligns closely with physics subjects tied directly to everyday experiences, such as temperature, heat, and displacement (Almas & Nugraheni, 2023).

These specific curricular concepts are frequently perceived by students as challenging (Yuliati et al., 2023). Although temperature and heat involve abstract principles, their practical manifestations appear universally, yet learners frequently struggle to differentiate between the two terms. This pattern mirrors review findings indicating that temperature, heat, and displacement constitute the most prevalent science material utilized for enhancing Critical Thinking Skills at 25 percent. Difficulties arise from multiple factors, notably the conflation of heat and temperature in common vernacular, generating persistent misunderstandings that impede scientific comprehension. While temperature measures average particle kinetic energy, heat denotes energy transfer driven by thermal gradients, representing a vital distinction that remains widely misunderstood, given data showing roughly 37.64 percent of learners successfully answer related test items.

Additionally, approximately 21.9 percent of students encounter hurdles grasping foundational thermal concepts, whereas 20.9 percent struggle to apply associated mathematical formulas. The heavy representation of temperature, heat, and displacement in cognitive interventions underscores their theoretical complexity and instructional worth, offering rich platforms for nurturing advanced reasoning because they necessitate interpretation, analysis, evaluation, and inference. Nevertheless, empirical evidence indicates that student proficiency in these fields remains troubling, with research revealing that 40.5

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percent of individuals exhibit non-critical reasoning tendencies when confronting thermal science content.

3.3.3. RQ 3 : What is the most dominant learning medium used to improve critical thinking skills in science (Physics, Chemistry, Biology) learning in Indonesia (2019-2024)?

Synthesized review data establishes that Edmodo serves as the most prominent Learning Media deployed within Science Learning, capturing a utilization rate of 16.8 percent. Operating as a school-centric social network, this platform delivers specialized tools designed to facilitate instructional workflows. Key advantages include mirroring social media interfaces like Facebook, restricting class access exclusively to holders of specific group codes, functioning without cost, eliminating the necessity for local institutional servers, offering operational flexibility, receiving continuous developer updates, scaling across single classrooms or multi-school networks, accommodating students, educators, and parents simultaneously, enabling seamless communication, supporting collaborative teaching models, incorporating alert functionalities, and utilizing digital badges to boost learner engagement.

This digital platform functions effectively within Science Learning, particularly during physics instruction, while also demonstrating a capacity to elevate Critical Thinking Skills (Zainudin & Pambudi, 2019). Its adaptable architecture permits students to articulate perspectives openly during educational activities, cultivating a dynamic, learner-focused atmosphere. Such versatility encourages self-actualization, motivating participants to engage more intensely and productively. Furthermore, the platform streamlines dialogue, collaborative discussions, and resource retrieval, ultimately reinforcing student involvement, autonomy, and analytical rigor when executing academic assignments (Melatiya et al., 2020).

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3.3.4. RQ 4 : What is the most widely used learning model to improve critical thinking skills in science (Physics, Chemistry, Biology) learning (2019-2024)?

Analytical outcomes indicate that discovery learning functions as the primary Learning Model applied to boost Critical Thinking Skills within Science Learning, accounting for 60 percent of documented studies. This instructional framework proceeds through structured stages, namely presenting initial stimuli to learners, isolating pertinent questions, organizing collaborative discussion groups, guiding participants through data gathering and hypothesis formulation, prompting student-led conclusions, and directing individuals to share their discoveries (Lieung, 2019).

Implementing this pedagogical model effectively elevates Critical Thinking Skills. Prior research highlights that discovery learning successfully strengthens cognitive processing capabilities, allowing students to navigate concepts according to their individual comprehension speeds and learning tempos (Ridwan, 2021). Furthermore, this approach reinforces broader intellectual faculties and mental development (Priadi et al., 2021). By boosting active participation in educational tasks, the model encourages students to engage in diverse learning activities that inherently cultivate analytical reasoning.

4. Conclusion

Review outcomes demonstrate that physics represents the primary scientific discipline deployed to advance Critical Thinking Skills within Science Learning, constituting 54 percent of the evaluated literature. Analytical reasoning is vital for physics instruction because it assists learners in comprehending, interpreting, and clarifying physical events more successfully. Furthermore, a student's cognitive proficiency shapes their conceptual understanding and the overall success of the instructional process. Among various curriculum subjects analyzed, temperature, heat, and displacement emerged as the most prevalent topics due to their inherent complexity for learners. Although thermal concepts remain abstract, they connect directly to practical daily experiences, rendering them exceptionally suitable for fostering advanced cognitive growth.

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Regarding digital platforms, Edmodo functioned as the most frequent tool utilized in Science Learning, recording a usage rate of 16.8 percent. This school-centric social network delivers integrated features that streamline educational workflows, including communication channels, discussion forums, and resource accessibility. Its adaptable and interactive design makes it highly effective for physics instruction while concurrently strengthening Critical Thinking Skills. Additionally, the platform empowers students to articulate thoughts with greater freedom during lessons, thereby motivating self-actualization and active involvement in academic tasks.

Concerning instructional frameworks, discovery learning stood out as the principal Learning Model applied to enhance Critical Thinking Skills in Science Learning, capturing 60 percent of studies. This methodology nurtures intellectual development by permitting participants to acquire knowledge at their own speed while aligning with their individual conceptual comprehension levels. Furthermore, discovery learning stimulates active participation, allowing students to engage in diverse educational exercises that organically drive cognitive advancement and analytical reasoning.

DECLARATION OF GENERATIVE AI

During the preparation of this manuscript, the authors used AI-assisted tools, including ChatGPT, Grammarly, and QuillBot, to support language editing and improve grammatical accuracy. The authors carefully reviewed and edited the output generated by these tools and take full responsibility for the content of the manuscript.

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