

## **Bridging Culture and Cognition: Deep Learning Strategies in Local-Wisdom-Based IPAS Classrooms**

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**Abstract:** Global educational reforms increasingly emphasize critical thinking, yet Indonesian elementary schools continue to face challenges in realizing this shift within the Merdeka Curriculum. A key gap persists between curriculum expectations and classroom practice, especially in integrating local wisdom with deep learning approaches. This descriptive qualitative study involved 41 teachers and 77 students through interviews, focus group discussions, observations, and document analysis, framed by the FRISCO reasoning model. The findings show that teachers understand core deep learning principles linking, reflection, and evidence-based reasoning but their implementation is constrained by limited time, uneven technological access, and varying student readiness. Integrating local wisdom through environmental practices, folklore, and cultural traditions significantly increased student engagement and improved critical thinking (N-gain = 0.47), although technology remained underutilized for inquiry-based tasks. These results underscore the need for continuous professional development and the design of culturally grounded learning resources that synergize local content, the FRISCO framework, and technology to achieve curriculum goals. The novelty of this study lies in its holistic integration of cultural knowledge, deep learning pedagogy, and a structured reasoning framework within the Merdeka Curriculum context. Its contribution provides empirical evidence and a conceptual model for developing context-responsive IPAS learning designs that connect technology, culture, and higher-order thinking.

**Keywords:** Critical Thinking, Deep Learning Strategies, FRISCO Framework, Local Wisdom, IPAS Education

### **A. Introduction**

Over the past decade, global educational reforms have shifted from rote learning toward developing higher-order thinking, creativity, and contextual understanding. This international push reflects growing recognition that traditional teacher-centered instruction is insufficient for preparing students to navigate complex real-world situations. Critical thinking has therefore become a foundational competency for lifelong learning, civic participation, and scientific problem-solving (Arjaya et al.,

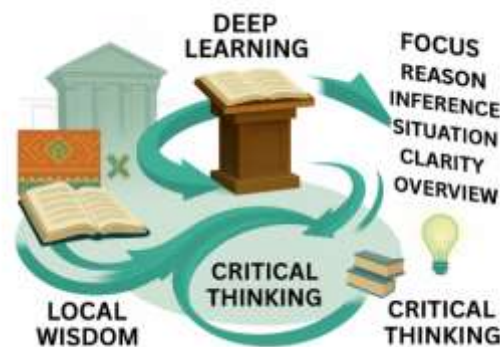
2024; Trisnowati et al., 2023). In parallel, integrating local wisdom into school curricula has been increasingly highlighted as a meaningful way to connect cognitive development with learners' cultural and ecological environments, fostering scientific literacy, cultural identity, and social responsibility (Fauzi et al., 2022; Priyangga et al., 2022; Siska et al., 2021; Suratno et al., 2020; Uge et al., 2019).

Responding to these global trends, Indonesia introduced the Merdeka Curriculum, which emphasizes student-centered, contextualized, and inquiry-driven learning aligned with competencies such as critical thinking, reflection, and problem-solving (Sabri et al., 2023; Santosa et al., 2024). Deep learning approaches characterized by comprehension, reflection, and the transfer of knowledge closely support these goals. When combined with local wisdom, deep learning creates authentic, culturally grounded learning experiences that strengthen meaning-making, empathy, and adaptive reasoning (Jumriani et al., 2021; M. W. Sari et al., 2023).

Despite these policy directions, the implementation of critical-thinking-oriented, local-wisdom-based learning in Indonesian elementary IPAS classrooms remains limited. Instruction tends to be teacher-centered, with constrained opportunities for inquiry, minimal use of digital tools, and learning materials that lack contextual relevance. These issues contribute to low student performance, with studies reporting an average of only 42.08% achievement across critical-thinking indicators (Febri et al., 2019; Setiawan et al., 2017). This gap indicates a persistent mismatch between curriculum aspirations and classroom realities.

Previous research shows that incorporating local wisdom into science education can improve critical thinking and engagement (Azura et al., 2023; Arfika et al., 2020). Inquiry-based pedagogies such as problem-based and project-based learning likewise enhance evaluative reasoning by situating learning in real-world contexts (Cantona et al., 2023; Hidayati & Purwaningsih, 2023). Evidence from mathematics learning similarly demonstrates the value of contextualized reasoning activities (Feriyanto & Putri, 2020). However, these studies typically focus on *either* local wisdom *or* inquiry pedagogy, and rarely examine their integration within a structured critical thinking framework.

At the same time, practical barriers persist. Many teachers and students lack familiarity with pedagogical tools designed to cultivate critical thinking within local scientific contexts. Technology, though available, is often used merely for content delivery rather than for supporting inquiry or reasoning (Sirait & Maulida, 2023). These challenges underscore the importance of conducting a systematic needs analysis to determine pedagogical readiness, resource availability, and contextual constraints before developing culturally grounded learning materials.



**Figure 1. Conceptual Framework: Integration of Local Wisdom and Deep Learning in IPAS Education**

The FRISCO framework (Focus, Reason, Inference, Situation, Clarity, Overview) provides a structured lens for guiding and assessing critical thinking. Integrating FRISCO with local wisdom and deep learning represents a promising approach for bridging curriculum expectations with classroom practice shown in figure 1. Deep learning strategies that emphasize reflection, conceptual integration, and real-world problem solving can further deepen student engagement when connected to culturally relevant tasks (Achmad & Utami, 2023; Adnyani & Suniasih, 2023; Sidiq et al., 2021). Yet, the synergy of *local wisdom* × *deep learning* × *structured reasoning* (FRISCO) remains underexplored in existing literature.

To address this gap, the present study conducts a comprehensive needs analysis to examine teacher and student readiness for implementing culturally grounded, deep-learning-oriented IPAS instruction aligned with the Merdeka Curriculum. This research uniquely integrates local wisdom, deep learning pedagogy, and FRISCO-based critical thinking assessment, offering both empirical insights and a conceptual foundation for designing context-responsive instructional materials. Research questions of this paper are 1) What is the level of pedagogical and technological readiness among teachers for implementing local-wisdom-based deep learning in IPAS classrooms? 2) How does the integration of local wisdom influence students' critical thinking skills, as measured through the FRISCO framework? 3) What are the primary challenges and enabling factors in implementing this integrated approach within the Merdeka Curriculum context?

## **B. Methods**

This study used a descriptive qualitative survey design to examine teachers' readiness and students' needs in developing local-wisdom-based IPAS materials within a deep-learning framework. Following (Creswell & Poth, 2024), this approach captured contextual nuances beyond quantitative reach, while purposive sampling (Welch & Patton, 1992) targeted information-rich participants. Grounded in deep learning

theory (Fullan & Langworthy, 2014) and a constructivist epistemology, the study aligned with the needs analysis approach of (Menggo et al., 2022) to inform culturally relevant material design. Conducted in Makassar’s public and private elementary and junior high schools implementing the Merdeka Curriculum, it involved 41 IPAS teachers and 77 students, whose diverse contexts enriched insights into readiness variations, as detailed in Table 1.

**Table 1. Participant Characteristics and Context**

School Type	Level	City/Region	Teachers (n)	Students (n)	IPAS yrs exp (teachers), M (SD)	Curriculum Status	Notes on local-wisdom exposure
Public	Elementary	Makassar urban	18	31	7.2 (3.1)	Merdeka active	Regular use of environment & folklore
Private	Elementary	Suburban	11	24	5.4 (2.6)	Merdeka partial	Occasional cultural projects
Public	JHS	Peri-urban	12	22	9.1 (4.0)	Merdeka active	Community practice modules

This study involved teachers and students from public and private elementary and junior high schools implementing the Merdeka Curriculum in Makassar and surrounding areas. Data were collected in naturalistic classroom settings to maintain contextual authenticity, following (Kvale & Brinkmann, 2009). Using purposive sampling (Welch & Patton, 1992), participants were selected for their rich insights into local-wisdom-based IPAS instruction. Teachers with at least three years of experience ensured pedagogical and curricular familiarity, while students were drawn from classes engaged in culturally contextualized learning. Multiple qualitative instruments—semi-structured interviews, FGDs, classroom observations, and document analyses—were employed to explore teacher readiness, student needs, and critical-thinking practices. Guided by (Krueger, 2014), interviews and FGDs used open-ended prompts; observations documented instructional interactions; and document analysis assessed the integration of local wisdom and critical thinking. All instruments underwent expert validation to ensure alignment with pedagogical and technological readiness (Afnani & Attalina, 2025).

The FRISCO model Focus, Reason, Inference, Situation, Clarity, and Overview adapted from (Hyytinen et al., 2023) structured the operationalization of critical-thinking indicators in data collection and analysis. Each dimension captured key reasoning aspects: identifying questions, constructing arguments, drawing conclusions, contextual awareness, clarity of expression, and reflective synthesis. These indicators guided interview questions, observation codes, and thematic organization to ensure analytical coherence. Table 2 summarizes the alignment between instruments, constructs, and FRISCO components, demonstrating consistency between research objectives and critical-thinking indicators.

**Table 2. Instrumentation Map to Constructs and FRISCO Indicators**

<b>Instrument</b>	<b>Construct(s) targeted</b>	<b>FRISCO indicator(s)</b>	<b>Example prompt/item</b>	<b>Validation evidence</b>
Semi-structured interview (teachers)	Pedagogical readiness; tech readiness; local-wisdom use	Focus, Reason, Situation, Overview	"Describe how you guide students from a local issue toward evidence-based conclusions."	Expert review; pilot with 3 teachers
FGD (students)	Engagement; preferences; equity of access	Focus, Clarity	"Which activities helped you explain ideas clearly to peers?"	Practitioner review
Observation sheet	Deep-learning enactment; classroom routines	Reason, Inference, Clarity	"Evidence of justification when presenting results."	Inter-rater calibration
Document analysis	Material quality; contextualization	Situation, Overview	"Alignment to local environmental problems."	Checklist reliability log

This study mapped research instruments to constructs and FRISCO indicators to assess pedagogical, technological, and contextual readiness in implementing deep-learning IPAS materials. The FRISCO framework supports global efforts to operationalize critical-thinking assessments with adaptable dimensions for primary and secondary education (Melawati et al., 2022; C. M. Putri et al., 2025). Data were gathered over three months through interviews, FGDs, classroom observations, and document analysis, focusing on teacher readiness, pedagogy, student engagement, and curriculum alignment, with triangulation enhancing reliability (Ibrahim et al., 2023). Analysis followed (Jiayuan et al., 2025) thematic framework, guided by FRISCO for critical-thinking indicators and Fullan's model for pedagogical and technological readiness (Afnani & Attalina, 2025), maintaining rigor through constant comparison and reflective memos. Validation ensured credibility, transferability, dependability, and confirmability via expert review, pilot testing, and peer debriefing, reflecting a synthesis of qualitative rigor and cultural sensitivity to understand teacher and student readiness in culturally responsive, innovative education.

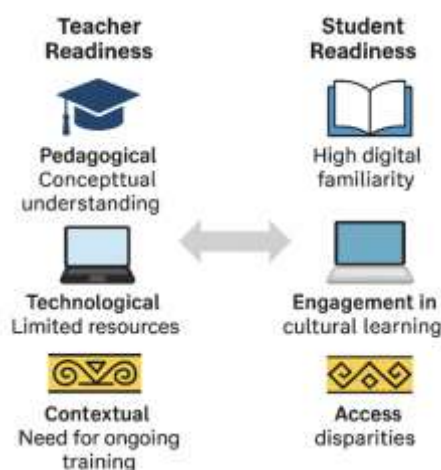
## **C. Results and Discussion**

### **Result**

Interviews with 42 IPAS teachers revealed a strong conceptual understanding of deep learning and critical thinking, defined as reflection, interdisciplinary connections, and real-world application, consistent with (Berdahl et al., 2021). Teachers employed strategies like storytelling, group discussions, experiments, and case studies, aligning with (Fullan & Langworthy, 2014) on motivating, challenging learning. However, effective implementation was limited by time constraints, varied student readiness, and resource shortages. Experienced teachers showed greater pedagogical

adaptability, supporting findings by (Sahrir, 2021; Wolff et al., 2021) on experience enhancing cultural integration and innovative teaching.

Regarding technological readiness, teachers demonstrated moderate to high familiarity with tools such as Google Classroom, Quizizz, and multimedia projectors, reflecting growing digital competence within the Merdeka Curriculum. As noted by (Astapenko, 2023; Zilli et al., 2021), digital readiness depends on prior training and motivation. While most expressed enthusiasm for tech integration in deep learning, confidence and skills were influenced by infrastructure and institutional support, echoing (Indahl et al., 2021; Kim et al., 2019) on the importance of technology-focused professional development for adoption of digital strategies.



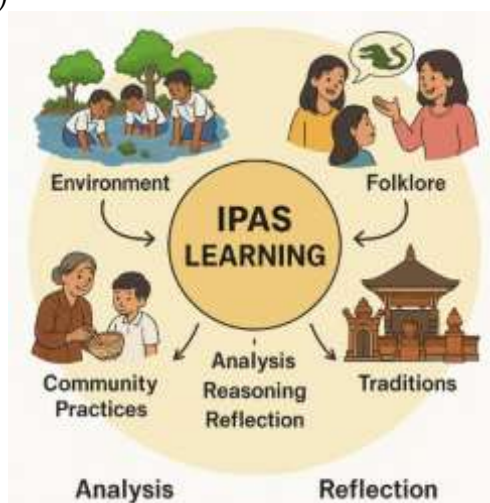
**Figure 2. Teacher and Student Readiness in Implementing Local-Wisdom-Based Deep Learning**

### Visual Representation of Teacher and Student Readiness Dimensions for Local-Wisdom-Based Deep Learning in IPAS Classrooms

Students showed high technological familiarity, frequently using computers, smartphones, Google, YouTube, and interactive quizzes for learning, supporting (Awang et al., 2021) on digital fluency boosting engagement. However, access disparities persist, especially in rural areas with limited connectivity and devices, echoing (Jumriani et al., 2021) on unequal access hindering tech-supported deep learning.

Students preferred hands-on experiments, games, and group discussions, valuing lessons tied to daily life and topics like environmental conservation, health, and local ecosystems, reinforcing (Fullan & Langworthy, 2014) view that meaningful learning blends joy and challenge. They also appreciated learning through local wisdom folklore and traditional practices—enhancing engagement and cultural pride, consistent with (Asrial et al., 2021; Uge et al., 2019) Local wisdom integration was

central in IPAS instruction, with teachers using cultural themes, environmental knowledge, and folklore as entry points. Students found culturally grounded content relatable, linking school knowledge to life experiences. This aligns with Muliarsa et al. (2024), who showed that local-wisdom-infused PBL improves critical and creative thinking (N gain = 0.47, moderate). Teachers noted that cultural content like traditional ecological practices and folk stories contextualizes abstract concepts, deepening comprehension and reflection, supporting (Damopolii et al., 2024; Verawati & Wahyudi, 2024)



**Figure 3. The Role of Local Wisdom in Deep Learning Contexts**

### **Illustrative Model of How Local Wisdom Contextualizes IPAS Learning Through Culture-Based, Environment-Linked, And Community-Driven Experiences**

Analysis using the FRISCO framework showed that students most easily developed the “Focus” skill identifying key problems especially when topics were linked to familiar cultural contexts. However, advanced skills like “Inference,” “Clarity,” and “Overview” required significant scaffolding, as students struggled to draw evidence-based conclusions and synthesize information, aligning with (Cahaya et al., 2024) on the need for structured reasoning opportunities. Reflective discussions and written summaries aided improvement, but ongoing guidance remained necessary. The gap between problem identification and reasoning echoes (Wahyuni, 2015) who emphasized sustained teacher facilitation to deepen reasoning. Teachers noted that continuous assessment through discussions, projects, and peer review strengthened FRISCO skills.

Implementation challenges included time constraints, varied student readiness, and inconsistent institutional support, paralleling (Hikmawati, Suma, et al., 2021) who stressed the need for comprehensive training and resources for successful Merdeka Curriculum adoption. Students faced technology access issues and difficulties with scientific terminology, especially those from lower socio-economic backgrounds, consistent with (Safitri et al., 2024) on equity concerns limiting deep learning

inclusivity. Students also struggled with evaluation and reflection, highlighting the need for scaffolded metacognitive support.

Document analysis revealed that existing IPAS materials are of acceptable quality but lack features supporting deep learning and local relevance. Both teachers and students called for more vivid visuals, interactive digital elements, and tasks suited to diverse abilities, echoing findings by (D. A. Putri et al., 2023; Syahfitri, 2024) that digital modules with local wisdom and interactivity enhance engagement and critical thinking. Current materials remain text-heavy with limited contextualization, reducing appeal and cognitive challenge. Participants recommended adding community-based projects, local problem-solving, and digital storytelling to revitalize IPAS learning.

Findings confirm that local-wisdom-based approaches positively impact critical thinking, with a moderate N gain (0.47) demonstrating how contextual learning bridges abstract concepts and students' realities. Komariyah & Laili, (2018) linked critical thinking to academic achievement, especially when tasks involve culturally relevant reasoning. Local wisdom enhances authenticity, engaging students through familiar narratives.

Technology emerged as a key enabler of deep learning. Tools like Google Classroom, Quizizz, and multimedia platforms facilitate interactive, collaborative inquiry, supporting 21st-century critical thinking (Yanti et al., 2024). However, many teachers still primarily use technology for content delivery rather than student-centered inquiry. Syahfitri & Muntahanah, (2023) suggest integrating technology within local-wisdom frameworks to boost engagement and reflection, highlighting the need for ongoing professional development focused on pedagogical integration.

The study aligns with Merdeka Curriculum goals of fostering independent, critical, culturally grounded learners. Integrating local wisdom in IPAS strengthens cultural identity and real-world engagement, enhancing inclusivity and curriculum relevance. Teacher readiness both technological and pedagogical is critical for success, consistent with (Vilmala et al., 2025) who linked teacher competence and resource availability to innovation sustainability.

Scaling deep learning in Merdeka Curriculum requires ongoing teacher training, equitable infrastructure, and support for innovation. Success depends on institutional readiness, supportive environments, resources, and mentoring for teachers. Future curricula should include flexible, locally adaptable modules to develop 21st-century skills. While Indonesian teachers and students are prepared to incorporate local wisdom and deep learning in IPAS education, they need stronger structural, pedagogical, and technological support. Combining FRISCO critical thinking with

culturally relevant pedagogy and technology can help realize the curriculum's transformative goals.

## Discussion

A key finding of this study is that teachers possess strong conceptual understanding of deep learning principles conceptual linking, reflection, and reasoning – yet struggle to consistently translate these principles into classroom practice. This pattern reflects a common challenge in transforming instructional paradigms: teachers may understand new pedagogical ideals but lack the structural conditions to implement them. Previous studies similarly report that deep learning flourishes when teachers have adequate time, scaffolding tools, and institutional support (Mardhiah et al., 2021; Sudjarwo et al., 2018). Our findings extend this literature by illustrating *why* misalignment persists in Indonesian IPAS classrooms: teachers face competing pressures of curriculum completion, varied student readiness, and uneven digital infrastructure. Unlike studies that highlight teacher resistance as a barrier, our results suggest that the constraint is not willingness but *capacity*, shaped by systemic conditions. This distinction is important because it redirects improvement efforts from individual-level deficits to institutional-level supports.

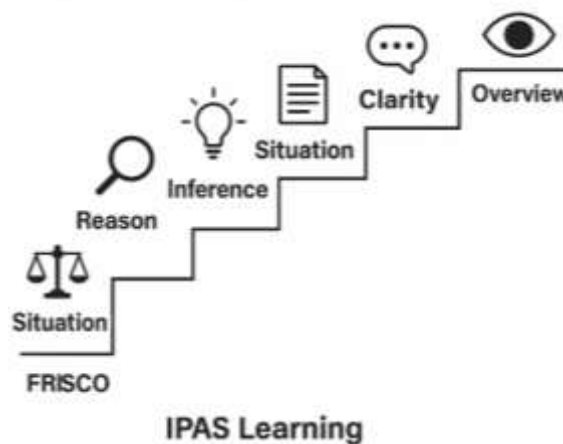


Figure 4. Application of the FRISCO Framework in IPAS Learning

Another major finding is the value teachers found in applying the FRISCO framework for both planning and assessment. Teachers relied heavily on “Focus” and “Reason,” yet struggled with more complex indicators such as “Inference,” “Clarity,” and “Overview.” This pattern is consistent with Ennis (Paidit et. al., 2023), who argues that higher-order reasoning develops only when students and teachers engage in sustained reflection and iterative feedback. However, our findings refine existing theory by demonstrating that *culturally contextualized* FRISCO tasks are particularly effective for bridging abstract reasoning with lived experiences. This suggests that FRISCO is not merely an assessment framework—it is a *pedagogical scaffold* that can deepen inquiry when integrated with meaningful contexts. The uneven

implementation observed in this study further implies that FRISCO-based professional development must explicitly model how to design tasks that gradually build the full spectrum of critical thinking skills.

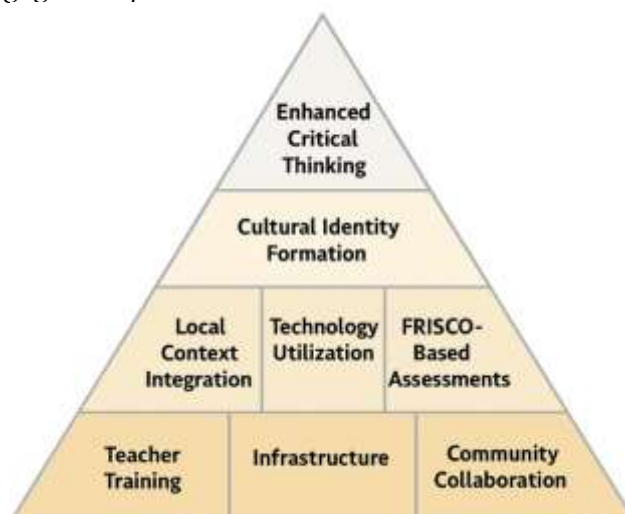
The study demonstrates that integrating local wisdom provides authentic, culturally resonant contexts that promote deeper analytical engagement. Students were able to connect scientific and social concepts with real-world experiences embedded in folklore, environmental practices, and community culture. This confirms previous research showing that contextualized and culturally grounded learning improves critical thinking (Azura et al., 2023; Arfika et al., 2020). However, our findings contribute new insights: gains in critical thinking (N-gain = 0.47) emerged not simply because content was contextualized, but because *local wisdom enabled the activation of FRISCO components* through real situations. This synergy between culture and reasoning frameworks has been underexplored in the literature. Yet, disparities across schools reveal that contextual learning depends heavily on teacher experience and resource availability. These variations highlight the need for policies supporting access to localized materials, partnerships with cultural institutions, and curated local resource banks to sustain culturally responsive IPAS instruction.

Despite teachers' high digital familiarity, this study finds that technology is primarily used for content delivery rather than for inquiry, collaboration, or multimodal reasoning. This resembles findings by R. Sari et al. (2024), yet our study adds nuance by showing that teachers' digital competence does not automatically translate into *pedagogical* digital competence. The gap lies not in operational skill but in the absence of models demonstrating how digital tools can mediate deep learning tasks such as hypothesis testing, evidence evaluation, or inference construction. Prior studies on digital comics, interactive media, and local-wisdom-based digital modules highlight their potential to enhance critical thinking (Syahfitri, 2024), but our findings show that such tools are rarely used in practice. This suggests the need for a shift from "technology for access" to "technology for inquiry," requiring structured teacher training that connects digital pedagogy with deep learning goals.

The integration of cultural knowledge and digital media emerged as a powerful yet underutilized opportunity. When students engaged with digital storytelling, virtual field trips, or interactive maps featuring local contexts, they demonstrated heightened engagement and reasoning. This aligns with Fitriyah et al. (2025) and Vilmala et al. (2025), who found that inquiry-based models grounded in local contexts significantly improve critical thinking. Our findings extend this by identifying *synergy* as the key mechanism: digital tools amplify local wisdom by enabling multimodal exploration of cultural phenomena, while local wisdom enriches deep learning by anchoring abstract thinking in lived experiences. However, this synergy is fragile without equitable infrastructure, supportive leadership, and curriculum flexibility. Thus, achieving transformative integration requires an ecosystem approach where

technological investment, school–community partnerships, and policy coherence work in concert.

The study reveals that implementation challenges time constraints, uneven digital access, student readiness gaps, and curriculum pressures mirror trends reported in evaluations of the Merdeka Curriculum (Vilmala et al., 2025). These challenges suggest that innovative pedagogies cannot be sustained without systemic support. Our findings emphasize that teacher innovation is closely intertwined with institutional readiness. Deep learning flourishes only when teachers have autonomy, mentorship, and curricular flexibility; otherwise, adoption remains superficial. This insight refines existing critiques of Indonesian curriculum reform by showing that the barrier is not merely policy–practice misalignment but the *absence of structures that protect and nurture pedagogical experimentation*.



**Figure 5. Transformative Pathways for Implementing Local-Wisdom-Based Deep Learning under the Merdeka Curriculum**

Theoretically, this study demonstrates that combining the FRISCO framework with culturally grounded deep learning creates a coherent model for cultivating critical thinking. The findings show that FRISCO functions effectively not only as an assessment tool but also as an instructional design framework that guides students' reasoning processes in a structured manner. At the same time, local wisdom enriches critical thinking by providing authentic situations that activate FRISCO indicators more meaningfully. Deep learning becomes more powerful when contextualized within cultural narratives, addressing critiques that it can be overly abstract or detached from students' lived realities. The synergy between cultural context and structured reasoning expands existing theories of culturally responsive pedagogy by adding a systematic reasoning component that has been largely absent from prior frameworks.

This study has several limitations. First, the sample size is relatively small and limited to schools in Makassar, which may restrict generalizability to other regions with different cultural and infrastructural conditions. Second, the qualitative design, while offering rich insights, introduces potential researcher bias and limits causal claims. Third, variations in teacher interpretation of FRISCO and local wisdom may influence findings. Future research should involve larger, more diverse samples; mixed-methods approaches to capture both depth and generalizability; and experimental designs testing the effectiveness of FRISCO-based local-wisdom modules across different contexts.

#### **D. Conclusions**

This study offers a synthesized understanding of how culturally grounded content, deep learning strategies, and the FRISCO framework can be meaningfully integrated to advance critical thinking in IPAS education under the Merdeka Curriculum. Rather than merely demonstrating isolated benefits, the study highlights the conceptual value of aligning cultural relevance with structured reasoning and guided inquiry, thereby offering a coherent model for context-responsive science learning in Indonesian elementary schools. These insights contribute to ongoing national efforts to position critical thinking as a core competency while ensuring that learning remains connected to local identities and lived experiences. To translate these contributions into sustainable practice, several strategic recommendations emerge. Policymakers should strengthen support for equitable digital infrastructure and curricular flexibility that enables schools to incorporate local wisdom meaningfully. Teacher education institutions and school leaders need to prioritize targeted professional development focusing on FRISCO-aligned lesson design, scaffolding inquiry processes, and leveraging digital tools to deepen reasoning rather than simply deliver content. Such coordinated efforts can ensure that culturally responsive deep learning becomes a consistent pedagogical reality rather than an isolated innovation. In the future, research should implement quasi-experimental, mixed-methods, or longitudinal approaches to assess the effect of FRISCO-based local-wisdom modules on students' critical thinking in various socio-economic and geographical settings. Scholars should also investigate how culturally ingrained deep learning influences long-lasting cognitive growth, the formation of cultural identity, and students' ability to interact with real-world environmental and social challenges. Broadening this area of study will enhance the foundation of evidence for the transformation of education in Indonesia and aid in the creation of more equitable, culturally relevant, and intellectually demanding IPAS learning environments.

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