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Teachers' Strategies, Challenges, and Enablers in Implementing Deep Learning in Indonesian Senior Secondary Education: A Scoping Review

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Abstract
Following the enactment of Permendikbudristek No. 12/2024 and Permendikdasmen No. 13/2025, pedagogical Deep Learning (DL) has been institutionalized within Indonesia's Kurikulum Merdeka. Despite growing adoption, comprehensive evidence mapping DL practices across senior secondary education remains fragmented. This study addresses this gap by presenting the first cross-study synthesis on DL implementation in Indonesian senior secondary schools (SMA/SMK/MA) from 2020–2026, introducing a novel three-tier barrier taxonomy and an empirical enabler framework for teacher professional development. Guided by the Arksey and O'Malley framework and PRISMA-ScR guidelines, 398 records retrieved from Publish or Perish and Scopus AI were screened, yielding 27 eligible SINTA- and Scopus-indexed articles for thematic synthesis. Eight instructional strategies emerged, led by Mindful-Meaningful-Joyful (MMJ) learning (25.9%), Project-Based Learning (14.8%), and AI/technology-assisted DL (14.8%). Implementation barriers were predominantly internal, stemming from teachers' pedagogical habits and conceptual misconceptions (66.7%), followed by structural constraints (29.6%) and policy burdens (7.4%). Nevertheless, 100% of reviewed studies reported positive cognitive and affective student outcomes, primarily enabled by Kurikulum Merdeka's regulatory flexibility (33.3%), digital learning media (25.9%), and targeted teacher coaching (14.8%). Sustaining DL transformation in Indonesian secondary schools requires shifting professional development from one-off workshops toward continuous, practice-based coaching that transforms teachers' pedagogical paradigms.

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Introduction

The transformation of the 21st-century global educational landscape demands a fundamental shift from a rote-learning paradigm toward an orientation emphasizing deeper, more reflective, and contextual understanding (Syaifulloh, 2026). Within this framework, the concept of pedagogical Deep Learning (DL) has emerged as a systematic response to the inadequacy of traditional instructional models in equipping students with the critical thinking, creativity, collaboration, and communication competencies required in the Society 5.0 era. Fullan et al. (2018) define DL as a learning process that encourages students to construct profound understanding through six global competencies: character, citizenship, collaboration, communication, creativity, and critical thinking (the 6Cs). In Indonesia, the momentum for this transformation has accelerated following the enactment of Minister of Education, Culture, Research, and Technology Regulation (*Permendikbudristek*) No. 12 of 2024 and Minister of Primary and Secondary Education Regulation (*Permendikdasmen*) No. 13 of 2025, which formally adopted pedagogical DL as a core approach within *Kurikulum Merdeka*.

This policy emphasizes three operational principles, mindful, meaningful, and joyful, collectively known as the MMJ principles (Chotimah et al., 2025; Gultom, (2025). Consequently, Indonesia stands among the developing nations actively adapting DL frameworks from developed countries, particularly Australia and Finland, to fit its unique and diverse educational ecosystem (Suwandi et al., 2024). The urgency of this transformation is underscored by data from the Teacher Competency Test (*Uji Kompetensi Guru* [UKG]), which revealed that approximately 81% of Indonesian teachers failed to meet the minimum competency threshold, with senior secondary school teachers averaging a score of only 62.7, indicating a substantial pedagogical capacity gap in preparing for DL implementation (Nasrullah & Rahmanto, 2026). This reality demonstrates that adopting DL policies without a thorough understanding of field-level implementation strategies risks creating a disconnect between normative policy aspirations and actual classroom pedagogy.

Senior secondary education encompassing general senior high schools (*Sekolah Menengah Atas* [SMA]), vocational high schools (*Sekolah Menengah Kejuruan* [SMK]), and Islamic senior high schools (*Madrasah Aliyah* [MA]), serves as a critical arena for DL implementation, given its pivotal role as a bridge between basic education and higher education or the workforce. At this level, deep, competency-based learning is an urgent imperative, particularly for cultivating students capable of critical thinking, complex problem-solving, and flexible adaptation within rapidly evolving contexts. However, empirical realities in the field paint a contrasting picture. Nasrullah and Rahmanto (2026) and Serena et al. (2026) identify that DL implementation across Indonesian schools continues to face severe obstacles, including low teacher digital literacy, inequitable infrastructure, and weak institutional change management. More alarmingly, Rahayu (as cited in Nasrullah & Rahmanto, 2026) found that many teachers still misconstrue DL as an entirely new curriculum rather than a pedagogical approach designed to transform classroom learning and interaction. This conceptual misconception directly undermines the optimal execution of DL at the SMA/SMK/MA levels, precisely where teachers require the most comprehensive mastery to design mindful, meaningful, and joyful learning experiences. Further studies corroborate these findings, identifying teacher pedagogical readiness, resource constraints, and resistance to change as

primary barriers impeding effective DL adoption in secondary education. In the SMK context, these challenges are compounded by the need to integrate DL with specific vocational competency standards, whereas in Islamic boarding school (*pesantren*)-based MAs, spiritual dimensions and local wisdom must be carefully incorporated when designing contextualized DL strategies.

Despite the rapid growth of academic discourse on pedagogical DL in Indonesia, significant research gaps persist within the extant literature. First, existing studies are largely fragmented, typically focusing on a single subject, school, or instructional strategy, resulting in the absence of a comprehensive evidence map detailing DL strategy variations across subject clusters at the SMA/SMK/MA levels. Sadrah Mesak Manik et al. (2025) note that cross-national comparative studies require systematic implementation maps, yet such a baseline map remains unavailable for the Indonesian context. Second, barriers encountered by teachers in implementing DL have not yet been classified into a structured taxonomy distinguishing internal, structural, and policy-related constraints, a classification essential for designing targeted interventions. Third, the enabling factors (enablers) driving successful DL implementation in SMA/SMK/MA settings have not been systematically synthesized from existing literature, even though such insights are critical for policymakers and teacher professional developers. Moreover, most existing reviews fail to clearly differentiate between the impacts of DL on students' cognitive versus affective competencies, limiting the specificity of practical implications for educators. Collectively, these gaps create a knowledge void that directly constrains stakeholders including teachers, school principals, curriculum developers, and policymakers, in optimizing sustainable DL implementation across Indonesian senior secondary schools (Tri Ariqoh Kholisah et al., 2025).

Building upon these identified gaps, this study aims to address this void through a systematic and comprehensive scoping review. A scoping review was selected as the research design due to its distinct capability to map the extent and nature of evidence on an emerging topic, identify research gaps, and synthesize findings across diverse study designs without restricting inclusion to a single methodology (Arksey & O'Malley, 2005). Specifically, this study seeks to answer three research questions: (1) what are the characteristics and variations of Deep Learning implementation strategies at the senior secondary education level based on scientific literature mapping? (2) what are the primary barriers faced by teachers, and what are their implications for student learning outcomes and quality in Deep Learning implementation? (3) what enabling factors or key drivers optimize the execution of Deep Learning in senior secondary schools?

The novelty of this study lies in three core contributions: first, it provides the first cross-study synthesis specifically examining DL implementation in Indonesian SMA/SMK/MA institutions spanning 2020–2026; second, it develops a three-tier barrier taxonomy (internal, structural, and policy) to serve as an evidence-based reference for targeted interventions; and third, it maps enabling factors that can be directly translated into policy recommendations for Teacher Continuing Professional Development (*Pengembangan Keprofesian Berkelanjutan* [PKB]) in the *Kurikulum Merdeka* era. Thus, this study moves beyond merely describing existing phenomena to establish an empirical foundation necessary for accelerating pedagogical transformation in Indonesian senior secondary education.

Method

This study employed a scoping review design as its primary methodological approach. A scoping review was chosen to map the breadth and nature of evidence within an emerging field, pinpoint research gaps, and synthesize findings across heterogeneous study designs without methodological restrictions. This aligns directly with the study's objective of generating a comprehensive evidence map of strategies and challenges in implementing Deep Learning (DL) in Indonesian senior secondary education. The methodological design adheres to the seminal scoping review framework established by Arksey and O'Malley (2005), who define scoping studies as aiming "to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available" to inform practice, policy, and future research. This framework comprises five sequential stages: (1) identifying the research questions; (2) identifying relevant studies; (3) study selection; (4) charting the data; and (5) collating, summarizing, and reporting the results. All five stages were executed sequentially and systematically documented throughout this investigation.

This framework was further strengthened and refined using the methodological guidance of Peters, Marnie, et al. (2020), which emphasizes developing an *a priori* research protocol, utilizing standardized data extraction forms, and maintaining rigor and consistency during study selection and synthesis. Furthermore, Peters, Godfrey, et al. (2020) clarify that a scoping review differs fundamentally from a systematic review in that it does not mandate formal quality appraisal of primary studies, thereby permitting a broader, more inclusive coverage of literature across diverse research paradigms.

Table 1. Inclusion and Exclusion Criteria

Dimension	Inclusion Criteria	Exclusion Criteria
Document Type	Peer-reviewed scientific journal articles (empirical research, literature reviews, case studies, classroom action research [CAR], community service [PkM])	Textbooks, technical reports, unpublished theses/dissertations, conference proceedings
Publication Year	2020–2026	Published outside the 2020–2026 timeframe
Indexing	Indexed in SINTA 1–5 and/or Scopus	Not indexed in the specified databases
Language	Indonesian or English	Languages other than Indonesian and English
Context	Examines Deep Learning implementation at the senior secondary level (SMA/SMK/MA) in Indonesia	Contexts outside senior secondary education or outside Indonesia
Accessibility	Full text available online	Abstract-only availability

Transparency and traceability in reporting were ensured by adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines developed by Tricco et al. (2018). As Tricco et al. (2018) note, PRISMA-ScR provides a 20-item essential reporting checklist plus two optional items designed to enhance reporting rigor across the title, abstract, introduction, methods, results, discussion, and funding sections. Applying PRISMA-ScR ensures that every phase of the literature selection process is verifiable and replicable by future researchers. The analytical process was conducted through stages of data reduction, thematic clustering, and final synthesis, yielding a comprehensive mapping of DL implementation strategies and challenges in senior secondary

education. Consequently, this methodology establishes a systematic and credible foundation for holistically understanding DL implementation and advancing evidence-based instructional practices.

Results and Discussion

Results

Dari Literature searches conducted via Publish or Perish and Scopus AI using theme-related keywords yielded an initial pool of 400 articles. After removing 2 duplicates, 398 unique records remained for screening. Following rigorous curation against the predefined eligibility criteria (Table 1), 27 journal articles met all inclusion requirements and were retained for thematic mapping, as detailed below.

Table 2. Data Curation Results Based on Eligibility Criteria ($n = 27$)

Category / Characteristic	Frequency (n)	Percentage (%)
Published in 2025–2026	24	88.9%
Published in 2024	3	11.1%
Qualitative design	8	29.6%
Community Service (*PkM*) design	7	25.9%
Quantitative experimental design	4	14.8%
Classroom Action Research (PTK/CAR) design	4	14.8%
Review / SLR / Meta-analysis	2	7.4%
Survey and evaluation design	2	7.4%

As shown in Table 2, 88.9% of the included articles ($n = 24$) were published between 2025 and 2026, reflecting that DL implementation in SMA/SMK/MA settings represents a highly active and contemporary academic discourse. Only 3 articles (11.1%) were published in 2024, illustrating the surge in research momentum triggered by the enactment of *Permendikbudristek* No. 12 of 2024 establishing *Kurikulum Merdeka* as the national curriculum. Methodologically, qualitative designs predominated with 8 articles (29.6%), followed by Community Service (*PkM*) initiatives with 7 articles (25.9%), quantitative experimental designs with 4 articles (14.8%), Classroom Action Research (CAR) with 4 articles (14.8%), literature reviews/SLRs/meta-analyses with 2 articles (7.4%), and survey/evaluation designs with 2 articles (7.4%). The predominance of qualitative and *PkM* studies indicates that field-level DL implementation remains largely in an exploratory and teacher capacity-building phase, with relatively limited large-scale empirical evidence measuring long-term student learning outcomes.

Variations in Deep Learning Instructional Strategies. Mapping the 27 reviewed articles identified eight distinct strategies for implementing Deep Learning across Indonesian SMA/SMK/MA schools. Their frequency distribution is presented in Table 3.

Table 3. Distribution of Deep Learning Strategies/Models ($n = 27$)

Deep Learning Strategy / Model	Frequency (n)	Percentage (%)
MMJ (Mindful-Meaningful-Joyful)	7	25.9%
PjBL (Project-Based Learning)	4	14.8%
AI/Technology-Assisted DL	4	14.8%
PBL (Problem-Based Learning)	3	11.1%
HOTS-PISA Assessment	2	7.4%
ADLX, Differentiated DL, DL-Guidance & Counseling (DL-BK)	1 (each)	3.7% (each)

The findings in Table 3 reveal that the Mindful-Meaningful-Joyful (MMJ) learning approach is the most prevalent strategy, appearing in 7 studies (25.9%). MMJ represents the three core principles established by the Ministry of Primary and Secondary Education as the operational foundation of DL within *Kurikulum Merdeka*: mindful, meaningful, and joyful learning. Utilizing the MMJ strategy aligns closely with the dimensions of the *Profil Pelajar Pancasila* (Pancasila Student Profile), which prioritizes student-centered, flexible, and contextualized learning (Fathurrohim et al., 2026; Hardiyanti et al., 2026). This strategy has been implemented across diverse subjects—ranging from Economics and Fine Arts to Islamic Religious Education (*Pendidikan Agama Islam* [PAI])—highlighting its cross-disciplinary versatility. Particularly within PAI, the MMJ approach serves as a transformative alternative to traditional rote memorization, facilitating deeper value internalization among students (Wafa et al., 2025).

Project-Based Learning (PjBL) ranked second, appearing in 4 studies (14.8%). PjBL is widely regarded as the instructional method most congruent with the *Projek Penguatan Profil Pelajar Pancasila* (P5), an integral component of *Kurikulum Merdeka* (Nur Hakim et al., 2024), as well as a vital vehicle for cultivating 21st-century competencies (Alfiah et al., 2026). Within the SMK context, PjBL translates into authentic learning experiences directly aligned with industry-specific workforce competencies (Serena et al., 2026). Ranking third was AI/Technology-assisted DL (14.8%, $n = 4$), which leverages platforms such as Google Colab, DeepSeek, and Canva AI to scaffold deep learning. Subsequently, Problem-Based Learning (PBL) appeared in 3 studies (11.1%), predominantly implemented in PAI and Natural Sciences to sharpen critical reasoning through contextual problem analysis. Within these approaches, artificial intelligence acts as a collaborative partner for teachers in generating diverse instructional materials and memorable, personalized learning experiences tailored to individual student needs (Flora et al., 2026; Hidayati & Yudiantoro, 2025).

Three specialized, innovative strategies each appeared in a single study: Active Deep Learner Experience (ADLX), which integrates hands-on simulations to ensure experiential and profound conceptual mastery (Azis et al., 2025); Differentiated Deep Learning, which applies adaptive content delivery at SMAN 4 Banda Aceh (Hakim & Kiki Zakiyatus Solihah, 2026); and Guidance and Counseling-Integrated Deep Learning (DL-BK) implemented at SMK Negeri 10 Batam (Noyita et al., 2026). This strategic diversity demonstrates that DL implementation in Indonesian SMA/SMK/MA schools is highly contextual and adaptable to specific institutional conditions and student needs.

Implementation barriers and student learning outcomes. Analysis of the 27 articles yielded a three-tier classification of DL implementation barriers based on their underlying sources, as summarized in Table 4.

Table 4. Classification of Deep Learning Implementation Barriers
($n = 28$ occurrences across 27 studies)

Barrier Classification	Frequency (n)	Percentage (%)
Internal (teacher and student habits/competencies)	18	66.7%
Structural (time, facilities, infrastructure, technology)	8	29.6%
Policy/Curriculum(administrative burdens, regulations)	2	7.4%

Internal barriers predominated, cited in 18 studies (66.7%), encompassing low teacher digital literacy, inequitable access to digital facilities across schools, and a shortage of trained educators capable of adapting DL for inclusive education students (Jamaludin, 2025). Structural barriers were identified in 8 studies (29.6%), stemming from insufficient instructional hours and overly dense curriculum content demands, which conflict with the nature of deep learning—a process inherently requiring extended time to achieve optimal conceptual depth (Khotimah & Abdan, 2025).

Regarding student outcomes, 100% of the reviewed studies ($n = 27$) reported positive cognitive and affective impacts following DL implementation. Six distinct categories of positive student outcomes were identified, including a 34% improvement in cognitive abilities and critical thinking skills (Hadi et al., 2025). Furthermore, well-structured, interactive DL enhanced mathematical reasoning in vocational high school mathematics (Nada & Irawan, 2026) and improved students' proficiency in composing negotiation texts in Indonesian language courses (Flora et al., 2026). These outcomes confirm that DL effectively transforms the student learning experience from passive memorization to active comprehension and practical application (Khotimah & Abdan, 2025). Beyond cognitive gains, the literature demonstrates that DL significantly enhances affective dimensions, including self-reflection, metacognition, value internalization, and intrinsic learning motivation (Hakim & Kiki Zakiyatus Solihah, 2026; Hasan et al., 2025; Wafa et al., 2025).

Enabling factors for successful deep learning implementation. Mapping across the 27 articles identified six clusters of enabling factors (enablers) supporting successful DL execution, presented in Table 5.

Table 5. Distribution of Deep Learning Enablers ($n = 27$)

Enabling Factor (Enabler)	Frequency (n)	Percentage (%)
Kurikulum Merdeka as supportive regulatory framework	9	33.3%
Instructional media / learning technology	7	25.9%
Teacher training / workshops / coaching	4	14.8%
University–MGMP partnerships	3	11.1%
Principal / institutional leadership support	2	7.4%
Local wisdom / cultural context integration	2	7.4%

As shown in Table 5, *Kurikulum Merdeka* as a supportive regulatory framework was the most frequently cited enabler, appearing in 33.3% of studies ($n = 9$), signifying that this national policy acts as a primary catalyst granting teachers the autonomy to explore innovative DL methodologies. Instructional media and learning technologies ranked second (25.9%, $n = 7$), encompassing interactive flipbooks, AI platforms, Learning Management Systems (LMS), Quizizz, and digital student worksheets (*LKPD*). Teacher training, workshops, and coaching were cited in 14.8% of studies ($n = 4$), underscoring the pivotal role of continuous professional development in sustaining DL practices. Partnerships between universities and Subject Teacher Working Groups (*Musyawarah Guru Mata Pelajaran* [MGMP]) appeared in 11.1% of studies ($n =$

3) as mechanisms for ongoing teacher capacity building, followed by school principal/institutional support (7.4%, $n = 2$) and the integration of local wisdom/cultural contexts (7.4%, $n = 2$).

Discussion

The predominance of the MMJ strategy (25.9%) confirms that the Mindful-Meaningful-Joyful approach has become the primary operational framework for executing Deep Learning across Indonesian SMA/SMK/MA schools following the institutionalization of *Kurikulum Merdeka* via *Permendikbudristek* No. 12 of 2024. Suwandi et al. (2024) emphasize that MMJ serves as a deliberate pedagogical countermeasure to conventional teacher-centered, rote-oriented instruction. Theoretically, the *meaningful learning* component of MMJ is rooted in Ausubel's assimilation theory regarding the integration of new knowledge into learners' existing cognitive structures; *mindful learning* aligns with reflective awareness and heightened intellectual curiosity during the learning process (Hidayati & Yudiantoro, 2025); and *joyful learning* embodies meaningful emotional engagement as a catalyst for cognitive retention (Fathurrohim et al., 2026).

The prominence of PjBL as the second most common strategy (14.8%) is unsurprising given its robust empirical foundation within Indonesian vocational schools (SMK). Islamia et al. (2025) and Putra et al. (2025) found that PjBL, PBL, and inquiry-based learning are among the most effective models for actualizing DL, as they immerse students in contextual, real-world problems that stimulate critical thinking and collaborative problem-solving. Meanwhile, the emergence of AI/technology-assisted DL as the third-largest cluster (14.8%) reflects a new wave of pedagogical adaptation in the digital era, wherein technology acts as an instructional accelerator—streamlining the creation of teaching materials and adaptive practice assessments (Flora et al., 2026). Furthermore, integrating artificial intelligence has been shown to elevate student motivation through dynamic, visually engaging content delivery (Hidayati & Yudiantoro, 2025).

The overwhelming prevalence of internal barriers (66.7%), which far exceed structural constraints (29.6%), represents a finding of substantial theoretical and practical significance. It demonstrates that the primary obstacle to DL implementation in Indonesian senior secondary schools is not merely a deficit of physical infrastructure, but rather the challenge of shifting entrenched teacher pedagogical paradigms. Many educators endorse DL concepts intellectually yet remain practically tethered to didactic lecturing and one-way information transmission. Nasrullah and Rahmanto (2026) explain that this barrier manifests in teachers' difficulty designing learning scenarios that foster autonomous inquiry, compounded by student resistance resulting from years of passive conditioning.

Rogers' (2003) Diffusion of Innovations Theory offers a pertinent theoretical lens for interpreting this finding, positing that the adoption of pedagogical innovations is governed by perceived relative advantage, compatibility with existing values, and perceived complexity. Transitioning from *teaching as telling* to *teaching as facilitating deep inquiry* entails a profound reconstruction of professional identity that cannot be achieved through isolated, one-off workshops. As Rahayu (cited in Nasrullah & Rahmanto, 2026) observed, widespread misconceptions viewing DL as a new administrative curriculum rather than a broader

pedagogical philosophy directly fuel the internal barriers documented across 18 of the 27 reviewed studies.

Regarding student impact, the 100% consistency of studies reporting positive cognitive and affective outcomes indicates that when implementation barriers are effectively mitigated at least within research settings, Deep Learning demonstrably elevates instructional quality. Empirical gains, such as an increase in PAI learning mastery from 25% to 94% across two CAR cycles and a 40.63% rise in mean negotiation-text writing scores, substantiate that DL is far more than policy rhetoric, yielding tangible improvements in student achievement (Sadrah Mesak Manik et al., 2025). The identification of *Kurikulum Merdeka* as a primary enabler in 33.3% of studies highlights the vital role of national policy in cultivating an enabling environment for pedagogical reform. Beyond conferring formal legitimacy, the regulation unlocks structural flexibility that previously constrained instructional experimentation. However, Usman (as cited in Syaifulloh, 2026) notes that the most successful DL implementations are driven by teachers' intrinsic pedagogical beliefs and collaborative school cultures rather than mere regulatory compliance.

Teacher training and coaching (14.8%) further reinforce the argument that sustained professional development is indispensable for long-term DL success. Practice-oriented coaching clinics have proven substantially more effective at enhancing teachers' DL module-design competencies than conventional workshops, as they offer individualized, context-specific feedback (Hardiyanti et al., 2026). Similarly, Sadrah Mesak Manik et al. (2025) underscore the necessity of multi-stakeholder collaboration among educators, policymakers, and educational technology providers to ensure inclusive and sustainable DL scaling. Finally, partnerships between universities, MGMP networks, and schools (11.1%) offer a promising model for scaling DL transformation. Such collaborations facilitate the seamless transfer of contemporary pedagogical research into classrooms while generating authentic empirical data for higher education institutions. This aligns with Ismayati (as cited in Syaifulloh, 2026), who argues that core DL barriers, specifically training deficits and infrastructural disparities are most effectively resolved through coordinated multi-stakeholder ecosystems rather than isolated, single-sector interventions.

Several limitations of this scoping review warrant transparent acknowledgment. First, in accordance with the Arksey and O'Malley (2005) protocol, formal quality appraisal of primary studies was not performed, meaning studies with varying methodological rigor were weighted equally. Second, the heavy reliance on Google Scholar records retrieved via Publish or Perish (96.9%) may have resulted in an underrepresentation of studies indexed exclusively in Scopus or Web of Science. Third, potential publication bias must be considered, as 100% of the synthesized studies reported positive DL outcomes, which may partially reflect a systemic tendency against publishing null or negative findings. Fourth, institutional heterogeneity across general high schools (SMA), vocational schools (SMK), and *pesantren*-based madrasahs (MA) constrains the generalizability of findings across distinct school typologies.

Conclusion

Research on pedagogical Deep Learning in Indonesia is expanding rapidly in response to the Ministry of Primary and Secondary Education's (*Kemendikdasmen*) policy mandate

integrating DL into classroom practice. While the synthesized evidence confirms that DL consistently yields positive cognitive and affective outcomes among senior secondary students, limited pedagogical mastery compounded by conceptual misconceptions and uneven supporting infrastructure remain critical barriers across Indonesian schools. Future research should extend scoping reviews to junior secondary (SMP) and primary (SD) education levels to map developmental continuities in DL adoption. Additionally, targeted empirical investigations within specific disciplines, particularly Islamic Religious Education (PAI) and Mathematics, where DL has demonstrated notable transformative potential are recommended to establish robust, subject-specific pedagogical models.

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Authors' Note

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