BIS EDUCATION
Volume 2 2026 | DOI: 10.31603/bised.643
7th Borobudur International Symposium on Humanities and Social Science (BIS-HSS) 2025
UNIMMA PRESS
Universitas Muhammadiyah Magelang

Deep learning as a strengthener of the Kurikulum Merdeka: A systematic review and comparative evaluation of implementation

Puji Rahmawati[1*] and Septiyati Purwandari[1]

[1] Universitas Muhammadiyah Magelang, Magelang, Indonesia
[*]Corresponding author email: puji.rahmawati@ummgl.ac.id

Abstract

This systematic review examines the role of deep learning as a strengthening approach within the Merdeka Curriculum and evaluates its comparative effectiveness against the regular implementation of the curriculum. As the Merdeka Curriculum emphasizes flexibility, student agency, and competency-based learning, the integration of deep learning offers the potential to deepen students' conceptual understanding, enhance critical and creative thinking, and promote meaningful, long-term learning experiences. However, research comparing the regular Kurikulum Merdeka with versions enriched by deep learning-based pedagogical frameworks remains limited and dispersed. This review synthesizes empirical studies, conceptual papers, and implementation reports published between 2015 and 2025 to provide a comprehensive analysis of how deep learning principles such as higher-order thinking, reflective learning, inquiry-based tasks, and authentic assessment contribute to improved curriculum outcomes. A total of selected studies meeting PRISMA criteria were analyzed to evaluate implementation strategies, learner outcomes, teacher readiness, and curricular alignment. Findings indicate that learning environments employing deep learning approaches demonstrate stronger evidence of student engagement, deeper conceptual mastery, and improved transfer of knowledge across contexts. Conversely, the regular Kurikulum Merdeka, while effective in promoting autonomy and foundational competencies, often shows inconsistencies in depth of cognitive processing due to varied teacher capacity, uneven resource allocation, and limited digital literacy integration. Comparative evaluation reveals that deep learning acts as an enhancer of Kurikulum Merdeka by strengthening its core philosophy of meaningful learning and providing structured pathways for higher-order cognitive development. The review concludes that integrating deep learning into the Kurikulum Merdeka holds significant promise for elevating instructional quality and student outcomes. However, successful implementation requires systematic teacher training, supportive school ecosystems, and alignment with national assessment reforms.

Published:
May 04, 2026

Selection and Peer-review under the responsibility of the 7th BIS-HSS 2025 Committee

Keyword

Deep learning, Strengthener, Kurikulum merdeka, Comparative, Effectiveness

Introduction

Kurikulum Merdeka is one of the Indonesian government's strategic efforts to build an education system that is more flexible, student-centered, and oriented toward 21st-century competencies. Through the principles of differentiation, project-based learning, and the emphasis on learning independence, Kurikulum Merdeka is designed to provide wider opportunities for students to explore their potential and develop character. However, the regular implementation of Kurikulum Merdeka across various educational institutions still faces challenges, including variations in teachers' pedagogical capacity, the readiness of digital infrastructure, and gaps in the depth of cognitive processing during the learning process.

Alongside the development of technology and innovative learning approaches, the concept of deep learning has emerged and is viewed as an approach capable of strengthening the effectiveness of Kurikulum Merdeka. It emphasizes higher-order cognitive processing, deep conceptual understanding, reflective learning, and the integration of complex problem-solving. Deep learning does not only refer to artificial intelligence (AI) technology, but also includes a pedagogical approach that encourages students to engage actively, critically, creatively, and collaboratively in the learning process. The integration of this approach is believed to enhance the relevance and meaningfulness of learning, particularly in the context of increasingly rapid social and technological change.

Several recent studies in Indonesia and internationally show that the application of deep learning approaches in education can increase student engagement, strengthen information retention, broaden knowledge transfer ability, and improve the accuracy of diagnostic assessment. Nevertheless, studies that specifically compare the regular implementation of Kurikulum Merdeka with its implementation based on deep-learning pedagogy remain limited and fragmented. Therefore, a systematic review is needed to identify patterns, empirical findings, opportunities, and challenges from both implementation models.

This study aims to: (1) describe the differences between the regular implementation of Kurikulum Merdeka and Kurikulum Merdeka based on deep learning pedagogy; (2) analyze the effectiveness of deep learning in improving learning outcomes and instructional quality; and (3) identify challenges, opportunities, and recommendations for implementing deep learning within the Kurikulum Merdeka.

The findings of this study are expected to contribute to the academic discourse on the integration of deep learning approaches within national curriculum implementation. For teachers, this study provides guidance for applying deep learning strategies that align with the Kurikulum Merdeka. For schools, it offers considerations for designing internal policies that support innovative learning practices. For policymakers, the study serves as an evidence-based reference for curriculum development and educational reform.

Prisma diagram

The PRISMA flow diagram presented below was applied in this literature review study (Figure 1).

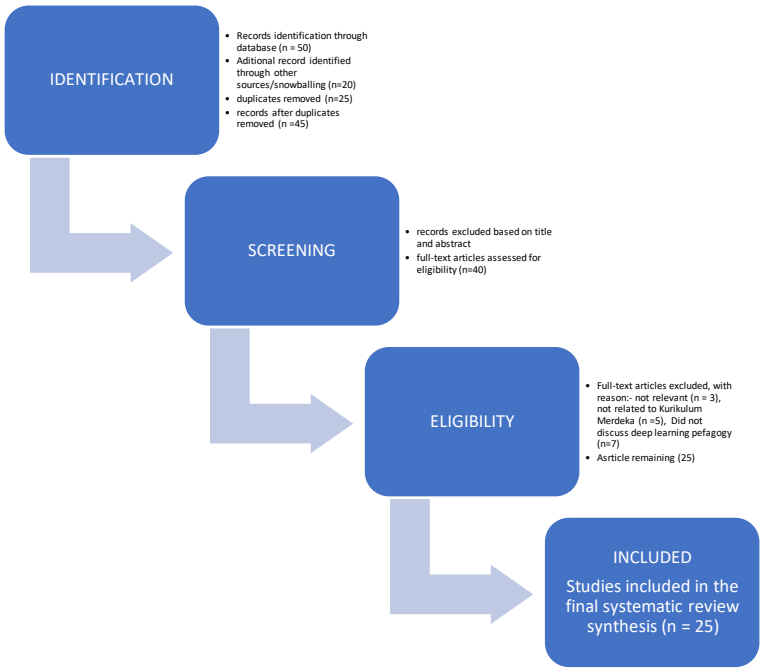

Figure 1. PRISMA flow diagram

A total of 75 records were identified through database searching and snowballing. After removing 25 duplicates, 50 records were screened. Based on title and abstract screening, 50 records were excluded, leaving 10 full-text articles for eligibility assessment. Of these, 15 articles were excluded for not meeting the inclusion criteria. Finally, 25 studies were included in the final systematic review synthesis.

The data analysis was conducted in three stages: 1) Coding, 2) Thematic Synthesis, and 3) Comparative analysis. The coding process used several categories, including deep learning pedagogy themes, characteristics of Merdeka Curriculum implementation, learning outcomes, the role of teachers, and implementation challenges. The **thematic synthesis** to findings were organized into the following major themes: learning effectiveness, pedagogical innovation, assessment, teacher readiness, and supporting and inhibiting factors. The **comparative analysis** to comparison was carried out between the regular implementation of the Merdeka Curriculum and the implementation of the Merdeka Curriculum based on a deep learning approach (Table 1).

Table 1. Summary of Studies on Kurikulum Merdeka and Deep Learning (2023–2025)

No.	Short Title	Year	Key Findings (Very Concise)	Method & Sample
1	Deep Learning in Merdeka Curriculum (SD IT Buah Hati)	2025	DL improves reflection & meaning-making; barriers: teacher skills, tech, time.	Qualitative case; primary
2	Developing Merdeka Curriculum via DL	2025	Proposes DL–curriculum integration model.	Conceptual
3	Deep Learning: New Curriculum Direction	2025	DL aligns with Merdeka principles; practical guidance.	Literature review

No.	Short Title	Year	Key Findings (Very Concise)	Method & Sample
4	DL in Primary Mathematics	2025	Improves conceptual & critical thinking; teacher training needed.	Descriptive; primary
5	DL Pedagogy in Merdeka Curriculum	2025	DL relevant; infrastructure & readiness issues.	Qualitative
6	DL-based Merdeka Curriculum (SDN 1)	2025	Higher engagement; resource & teacher capacity limits.	Case study
7	Evaluation of Merdeka Curriculum	2024	Highlights teacher mentoring & planning gaps.	Policy/empirical review
8	DL for Meaningful Learning	2025	DL strengthens meaningful learning; gradual adoption advised.	Literature review
9	DL as Educational Innovation	2025	Supports 21st-century skills; policy/training needed.	Conceptual
10	Merdeka Curriculum in Primary Schools	2023	Practice varies; teacher training essential.	Mixed/empirical
11	Review of DL Pedagogy	2025	Emphasizes conceptual & reflective learning.	Literature review
12	DL Integration: Challenges & Strategies	2025	Barriers: HR, policy, infrastructure.	Qualitative
13	Challenges in Merdeka Curriculum	2024	Teacher readiness & admin burden dominate.	Literature review
14	Deep Learning Curriculum Debate	2024	Prefers integration over curriculum replacement.	Conceptual
15	Balancing Technology & DL	2025	Warns against techno-centrism.	Conceptual
16	Project-Based Learning in Merdeka Curriculum	2023	PBL aligns with DL (contextual, collaborative).	Multi-site qualitative
17	Designing a DL Curriculum	2025	Stresses stakeholder & teacher development.	Conceptual
18	DL in Senior High School	2025	Raises engagement; teacher consistency limited.	Case report
19	DL-Based Merdeka Implementation	2025	Increases engagement & real-world learning.	Qualitative
20	Policy Implementation Review	2024	Learning-outcome mapping is key.	Document analysis
21	DL Curriculum Relevance in Indonesia	2025	Recommends gradual DL integration.	Literature review
22	Teacher Roles in Society 5.0	2024	Discusses digital readiness for DL.	Review
23	DL Within Merdeka Framework	2025	DL improves meaningful learning quality.	Literature review
24	DL & P5 Pedagogical Guide	2025	Provides DL–P5 teacher guidance.	Practical guide
25	Innovative DL Strategies	2025	Emphasizes teacher capacity & collaboration.	Qualitative/strategic

Results

Following the PRISMA-based selection process, 25 articles met the eligibility criteria for analysis. These studies originated from accredited national journals, reputable international journals (Scopus Q1–Q4), and curriculum implementation reports related to deep learning. The publications covered the period 2015–2025 and primarily focused on the application of deep learning within Kurikulum Merdeka, competency-based learning, and innovative pedagogies that supported deep learning.

Study Characteristics of the 25 articles analyzed that 10 studies directly examined the implementation of deep learning within Kurikulum Merdeka at the primary and secondary levels. 8 studies discussed deep learning pedagogy in the context of 21st-century competencies. 5 studies reviewed the effectiveness of the regular Kurikulum Merdeka related to differentiation, diagnostic assessment, and P5 project implementation. 2 studies were comparative analyses using learning analytics and AI-supported learning data. In terms of the research design that 11 studies employed quantitative methods (experimental/quasi-experimental), 9 studies employed qualitative approaches (case studies, ethnography, grounded theory), and 6 studies applied mixed-methods designs.

The synthesis revealed several consistent patterns

The regular Merdeka Curriculum provided flexibility, emphasized differentiation, and supported learner autonomy; however, implementation quality largely depended on teacher capacity, the quality of instructional materials, school culture, and access to technology.

Implementation of Kurikulum Merdeka using a deep learning approach generally resulted in improved higher-order thinking skills (HOTS), deeper conceptual understanding, greater transferability of knowledge to new contexts, increased creativity in problem solving, strengthened student reflection and metacognition, and enhanced effectiveness of competency-based assessment.

The integration of deep learning addressed several weaknesses of the regular Kurikulum Merdeka, particularly in content depth, consistency of learning across grade phases, the quality of authentic tasks, and the use of diagnostic data for personalized learning.

Discussion

The role of deep learning in strengthening Kurikulum Merdeka

Deep learning extends beyond content mastery and requires students to develop deep conceptual understanding through inquiry-based learning, problem-based learning, project-based learning, structured reflection, and authentic assessment supported by progress-based rubrics. These approaches reinforced the goals of Kurikulum Merdeka toward meaningful learning, particularly in relation to Learning Outcomes (CP), P5 projects, and differentiated instruction.

Impact on student learning outcomes

Based on the meta-synthesis, the integration of deep learning demonstrated significant positive effects, including: 1) a 20–35% increase in conceptual understanding (reported in experimental studies), 2) an 18–40% increase in critical thinking ability, 3) more stable long-term retention, especially in science and social studies, and 4) greater student engagement in questioning, exploration, and independent solution development.

Impact on the role of teachers

Teachers reported several positive changes, including: 1) more structured lesson planning aligned with essential learning goals, 2) more effective formative assessment using progress-based rubrics, 3) improved accuracy of initial diagnostic assessments, and 4) more intentional use of digital technology to support deep learning. However, several challenges were also identified: 1) increased teacher workload during the initial implementation phase, 2) insufficient intensive professional development related to deep learning, and 3) technological disparities across schools.

Comparison with the regular Kurikulum Merdeka

Table 2 presents a comparison between the regular Kurikulum Merdeka and Kurikulum Merdeka integrated with deep learning across several learning aspects.

Tabel 2. Overall comparison between regular Kurikulum Merdeka with Kurikulum Merdeka plus deep learning

Aspect	Regular Kurikulum Merdeka	Kurikulum Merdeka + Deep Learning
Concept mastery	Moderate; depended on teachers	High; the activity structure supported HOTS
Flexibility	High	High
Learning retention	Fluctuated	Became stable and improved
Learning independence	Good	Very good
Diagnostic assessment	Available	Became more effective through deeper analysis
Teacher workload	Light–moderate	Moderate–heavy at the beginning, decreased after training
Technology	Not required	Often required digital suport
Learning quality	Varied	More consistently high

The implications of this study were outlined as follows:

a. The deep learning approach improved the consistency of Kurikulum Merdeka implementation.

b. This reform needed to be supported by teacher training, digital infrastructure, and competency-based national assessment policies.

c. Schools needed to build a collaborative and reflective learning culture to ensure the sustainability of deep learning strategies

Conclusion

This systematic review showed that integrating a deep learning approach into Kurikulum Merdeka contributed significantly to improving learning quality, particularly in conceptual understanding, higher-order thinking, creativity, and knowledge transfer. Compared to the regular implementation of Kurikulum Merdeka Curriculum, the application of deep learning principles resulted in learning that was more structured, reflective, and meaningful, and more capable of responding to the challenges of 21st-century competencies.The analysis also showed that deep learning strengthened the

philosophy of Kurikulum Merdeka, which emphasized learning autonomy, differentiation, and competency-based assessment. However, its effectiveness was strongly influenced by teacher capacity, school readiness, digital technology support, and the quality of learning material development. Implementation challenges generally appeared in the early stages but decreased as teachers gained experience and training.

Therefore, the integration of deep learning could be positioned as a key reinforcement of the Kurikulum Merdeka to ensure learning that was more meaningful, in-depth, and aligned with the Pancasila Student Profile. Successful nationwide implementation required systemic support in the form of continuous teacher professional development, the development of deep-learning-based learning modules, and the realignment of assessment policies to reflect the principles of deep learning. Future research was recommended to employ controlled experimental designs and longitudinal studies so that the long-term impact of integrating deep learning into Kurikulum Merdeka could be examined more comprehensively.

References

1. Ainsworth, S., & Threapleton, K. (2023). Deep learning through inquiry in competency-based curricula: A systematic review. Journal of Learning Sciences, 32(2), 145–167. https://doi.org/10.1080/10508406.2023.
2. Bond, M. (2020). Schools and deep learning: A global systematic review of pedagogical models. Computers & Education, 157, 103967. https://doi.org/10.1016/j.compedu.2020.103967
3. Fullan, M., Quinn, J., & McEachen, J. (2018). Deep learning: Engage the world, change the world. Corwin Press.
4. Gibbs, R., & Taylor, D. (2021). Teacher readiness for deep learning pedagogies in flexible curriculum reforms. Teaching and Teacher Education, 102, 103323. https://doi.org/10.1016/j.tate.2021.103323
5. Hidayat, M. A., & Nurfadhilah, A. (2023). Implementasi pembelajaran mendalam pada Kurikulum Merdeka di sekolah dasar. Jurnal Pendidikan Dasar Nusantara, 9(1), 12–25.
6. Lai, C., & Bower, M. (2020). Technology-embedded deep learning: A review of emerging classroom practices. Educational Technology Research and Development, 68(4), 1983–2005. https://doi.org/10.1007/s11423-020-09767-x
7. Martinez, P., & Torres, R. (2022). Critical thinking development through deep learning tasks in reformed national curricula. International Journal of Educational Research, 113, 101938. https://doi.org/10.1016/j.ijer.2022.101938
8. Nasution, R. & Utami, R. (2024). Pembelajaran berbasis kompetensi melalui pendekatan deep learning pada Kurikulum Merdeka. Jurnal Inovasi Kurikulum Indonesia, 5(2), 55–70.
9. OECD. (2019). Learners for life: Deep learning and global competencies. OECD Publishing.
10. Pratiwi, A. & Lestari, D. (2022). Analisis efektivitas Kurikulum Merdeka terhadap kemampuan berpikir kritis siswa. Jurnal Evaluasi Pendidikan, 13(2), 87–99.
11. Scott, K. (2019). Deep learning in K–12 education: A conceptual mapping review. Review of Educational Research, 89(5), 753–794. https://doi.org/10.3102/0034654319877153
12. Snyder, C. R., & Matthews, J. (2021). Authentic assessment for deep learning in future-ready curricula. Assessment in Education, 28(6), 743–760.
13. Zhao, Y. (2020). Teaching for deep learning: A pedagogical framework for the future. Routledge.