

Learning Management for Advancing SDG 4 through a Deep Learning Approach: A Multi-Site Case Study in Indonesian Junior High Schools

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ABSTRACT

Objective: To describe, analyze, and construct propositions for a conceptual model of learning management through a deep learning approach at SMP Negeri 1 Gedangan and SMP Negeri 4 Sidoarjo. **Method:** The research employed a descriptive qualitative design using a multi-site case study approach. Data were collected through in-depth interviews, direct observation, and document analysis. The data were then analyzed through single-site and cross-site analysis to identify patterns, similarities, and conceptual findings from both research sites. **Results:** The findings show that the implementation of learning management through a deep learning approach requires principals to move beyond administrative and managerial functions toward a stronger role as instructional leaders. Principals facilitate teacher professional development through coaching, mentoring, and supportive clinical discussions. They also play a transformational role in translating curriculum vision into classroom practices based on mindful, meaningful, and joyful learning. Effective implementation is supported by teacher capacity building, principal managerial competence, curriculum integration, infrastructure optimization, digital technology utilization, and stakeholder collaboration. **Novelty:** Offering a conceptual model of learning management that integrates instructional leadership, teacher professional development, curriculum transformation, digital learning support, and stakeholder collaboration as strategic elements in implementing deep learning in junior high schools for SDG 4.

INTRODUCTION

Learning transformation has become an urgent agenda in junior high schools as students are increasingly required to develop critical thinking, creativity, collaboration, communication, and digital literacy. Conventional learning practices that emphasize memorization and teacher-centered instruction are no longer sufficient to prepare students for complex academic and social challenges. In this context, the deep learning approach offers an alternative framework for creating learning experiences that are more meaningful, contextual, reflective, and applicable to real-life situations. Deep learning enables students to understand the relationship between fundamental concepts within a subject and apply their knowledge and skills in both familiar and unfamiliar contexts (Bråten & Skeie, 2020).

Deep learning is not merely a teaching technique, but a pedagogical approach that encourages students to construct knowledge actively and deeply. It emphasizes the relationship between conceptual and procedural knowledge, as well as the ability to transfer understanding into new contexts (Hattie & Donoghue, 2016; Parker et al., 2011; Winch, 2017). In practice, deep learning is closely related to project-based learning, collaboration, inquiry, and critical reflection, allowing students to become active learners rather than passive recipients of information (Latif et al., 2025). This approach also aligns with constructivist

learning theory, which views learning as an active and social process in which learners build meaning through interaction, experience, and reflection (Vygotsky, 1978).

The implementation of deep learning is relevant to the current direction of educational development in Indonesia. The national education system emphasizes the development of students' potential to become individuals who are faithful, knowledgeable, creative, independent, democratic, and responsible citizens. This orientation is consistent with the objectives of Law Number 20 of 2003 concerning the National Education System. In addition, the Ministry of Primary and Secondary Education has introduced deep learning as an approach that strengthens the implementation of the existing curriculum rather than replacing it. Abdul Mu'ti (2024) emphasized that deep learning is not a new curriculum, but a learning approach that can be integrated into the current curriculum to help students understand learning materials more effectively and think more deeply during the learning process.

Deep learning is also closely related to the graduate competency standards stated in Permendikdasmen Number 10 of 2025. The regulation identifies eight dimensions of graduate profiles, namely faith and devotion to God Almighty, citizenship, critical reasoning, creativity, collaboration, independence, health, and communication. These dimensions show that education is expected not only to improve academic achievement but also to develop students' character, reasoning, social awareness, and life skills. Therefore, deep learning is considered important because it supports holistic student development through learning that involves intellectual, ethical, aesthetic, and kinesthetic dimensions. Fullan et al. (2014) describe deep learning as learning that promotes mindful, meaningful, and joyful experiences, enabling students to engage consciously, connect learning with real-life meaning, and participate in enjoyable learning activities.

The implementation of deep learning is also closely aligned with the global commitment to achieving Sustainable Development Goal (SDG) 4, which aims to ensure inclusive, equitable, and quality education while promoting lifelong learning opportunities for all (United Nations, 2015). SDG 4 emphasizes not only improving access to education but also enhancing the quality of teaching, strengthening teacher capacity, fostering innovative learning environments, and equipping students with higher-order thinking skills and competencies required for sustainable development. In this regard, deep learning provides a pedagogical framework that supports these objectives by encouraging meaningful learning experiences, critical thinking, collaboration, creativity, and learner autonomy. Consequently, strengthening learning management through a deep learning approach represents an important strategy for advancing educational quality and supporting the achievement of SDG 4 in Indonesian junior high schools.

However, the implementation of deep learning in schools is not without challenges. Several obstacles are commonly found, including limited teacher readiness, insufficient training, curriculum pressure, inadequate learning facilities, limited technology access, and assessment systems that are not yet fully aligned with deep learning principles. Teacher competence is a crucial factor because teachers are expected to move from being the main

source of knowledge to becoming facilitators who guide students in exploration, problem-solving, collaboration, and reflection. When teachers are not adequately prepared, learning may remain theoretical, teacher-centered, and less engaging for students. Nabila and Septiani (2025) explain that limited teacher training, cognitive-oriented assessment pressure, and resistance to pedagogical change are among the challenges in implementing deep learning.

The principal also plays a strategic role in ensuring that deep learning can be implemented effectively. Learning management requires more than administrative coordination; it needs instructional leadership that supports teachers, manages resources, strengthens curriculum implementation, and builds a school culture that encourages innovation. Strategies that promote reflection, discovery, and information integration tend to produce deeper and more lasting understanding among students (Akbar, 2023). Furthermore, deep learning supports the development of students' competencies to create positive contributions in their environment rather than merely achieving good examination results (Jubaedah, 2024). This indicates that successful implementation requires strong learning management involving planning, implementation, evaluation, teacher development, infrastructure support, digital technology, and stakeholder collaboration.

In Sidoarjo Regency, the implementation of deep learning at the junior high school level has become an important issue because schools are expected to respond to the demand for improved learning quality. SMP Negeri 1 Gedangan and SMP Negeri 4 Sidoarjo are two public junior high schools that have begun adopting innovative learning principles and implementing deep learning since the 2025/2026 academic year. Although both schools are under the same local education authority, they have different internal dynamics, school cultures, resource capacities, and leadership strategies. SMP Negeri 1 Gedangan has supported deep learning implementation through teacher training, infrastructure provision, digital facilities, and continuous professional development. Meanwhile, SMP Negeri 4 Sidoarjo has implemented deep learning with strong support from the principal, who also serves as a national facilitator for deep learning, although the school still faces challenges related to teacher preparation and infrastructure fulfillment.

These two schools provide important cases for understanding how deep learning is managed in real school contexts. The implementation includes learning planning, classroom practices, assessment development, teacher facilitation, technology utilization, and principal supervision. Preliminary observations indicate that teachers still face difficulties in fully implementing mindful, meaningful, and joyful learning. Some learning practices remain dominated by lectures, theoretical explanations, limited project-based activities, and classroom management challenges. Nevertheless, both schools show serious efforts to improve learning quality through leadership strategies, teacher development, and institutional support.

Based on this context, this study aims to describe, analyze, and construct propositions regarding the implementation of learning management through a deep learning approach at SMP Negeri 1 Gedangan and SMP Negeri 4 Sidoarjo. Specifically, this study examines learning planning, implementation, inhibiting factors, supporting factors, principal

evaluation, and principal strategies in monitoring deep learning implementation. Through a multi-site case study, this research is expected to provide a comprehensive understanding of how deep learning is managed in public junior high schools and to formulate a conceptual model that can support the improvement of learning quality in similar educational contexts.

RESEARCH METHOD

This study employed a qualitative approach using a multi-site case study design. The qualitative approach was selected because the research aimed to investigate the implementation of learning management through a deep learning approach in its natural setting without manipulation or experimental treatment. A multi-site case study was considered appropriate because the study focused on understanding how deep learning was planned, implemented, evaluated, and supported in two different educational contexts. According to Yin (2015), a case study is suitable when research seeks to answer “how” and “why” questions and aims to examine contemporary phenomena within real-life settings. This approach enabled the researcher to explore the implementation of deep learning comprehensively while maintaining the holistic characteristics of each research site.

The study was conducted at SMP Negeri 1 Gedangan and SMP Negeri 4 Sidoarjo, East Java, Indonesia. Both schools were selected because they had implemented the deep learning approach since the beginning of the 2025/2026 academic year and demonstrated strong commitments to educational innovation. The participants consisted of school principals, vice principals, and subject teachers who were directly involved in the planning, implementation, evaluation, and supervision of deep learning practices. The selection of participants was based on their knowledge, responsibilities, and experiences related to the implementation of deep learning in their respective schools.

Data were collected through three techniques: in-depth interviews, participant observation, and document analysis. In-depth interviews were conducted to obtain detailed information regarding learning planning, implementation, supporting and inhibiting factors, evaluation processes, and principals’ strategies in monitoring deep learning practices. Participant observation allowed the researcher to directly examine classroom activities, teacher-student interactions, learning environments, and school practices related to mindful, meaningful, and joyful learning. In addition, document analysis was carried out to review teaching modules, lesson plans, assessment documents, school policies, training materials, and other relevant documents. The use of these three techniques enabled data triangulation and provided a comprehensive understanding of the phenomenon under investigation (Bogdan & Biklen, 1982; Creswell, 2015).

Data analysis was conducted through two stages: single-site analysis and cross-site analysis. In the first stage, data from each school were analyzed independently through data condensation, data display, and conclusion drawing. This process enabled the identification of themes, patterns, and propositions emerging from each research site. In the second stage, findings from both schools were compared and integrated to identify similarities, differences, and theoretical relationships across sites. The analytical process followed the

interactive model proposed by Miles, Huberman, and Saldaña (2014), which emphasizes continuous interaction among data collection, data reduction, data display, and conclusion verification.

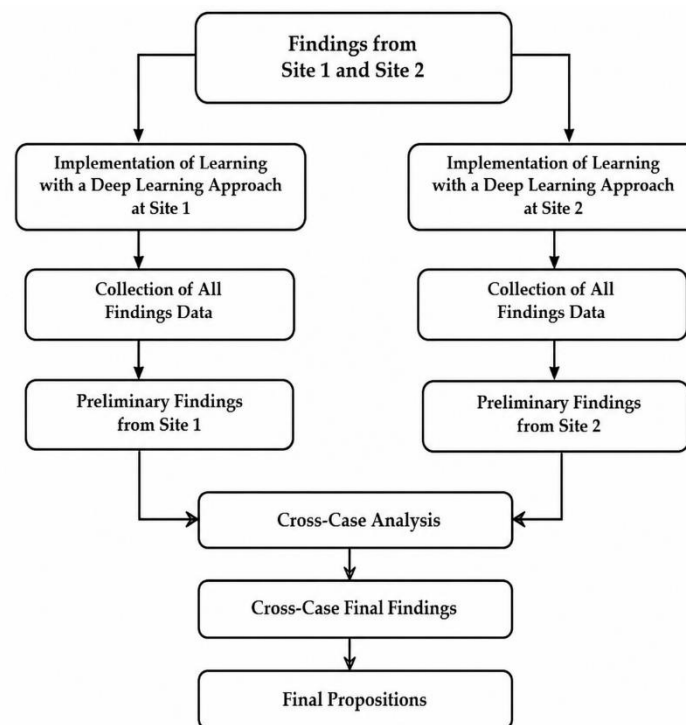


Figure 1. Cross-site data analysis model

Through cross-site analysis, theoretical propositions were developed by comparing findings from SMP Negeri 1 Gedangan and SMP Negeri 4 Sidoarjo. This process facilitated the construction of a conceptual model of learning management through a deep learning approach and allowed the researcher to identify common patterns and distinctive characteristics of implementation across the two schools.

To ensure the trustworthiness of the findings, this study applied four criteria: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1980). Credibility was established through prolonged engagement, persistent observation, triangulation, peer debriefing, referential adequacy checks, negative case analysis, and member checking. Transferability was supported by providing detailed descriptions of the research setting, participants, and implementation context. Dependability was maintained through systematic documentation of research procedures, field notes, interview transcripts, and supporting records. Confirmability was ensured through audit trails and continuous verification of findings to minimize researcher bias and strengthen the objectivity of the study.

RESULTS AND DISCUSSION

Results

Learning planning through the deep learning approach

Learning planning in both schools began with curriculum alignment to ensure that the principles of deep learning were integrated into teaching and learning activities. SMP Negeri 1 Gedangan focused on adapting the national curriculum through competency mapping and flexible learning arrangements, while SMP Negeri 4 Sidoarjo integrated the eight dimensions of the graduate profile into curricular and co-curricular programs.

Both schools required teachers to develop teaching modules that support meaningful and student-centered learning. The planning process emphasized learning experiences that encourage understanding, reflection, and application of knowledge. School principals also played a strategic role by establishing policies, allocating resources, and ensuring that instructional planning aligned with deep learning principles.

Teacher readiness was strengthened through various professional development activities. SMP Negeri 1 Gedangan promoted collaboration through internal learning communities and curriculum discussions, whereas SMP Negeri 4 Sidoarjo implemented In-House Training (IHT), dissemination programs, and the KRIDA learning community to improve teachers' competencies in implementing deep learning.

Cross-site findings indicate that both schools shared a commitment to curriculum alignment, teacher capacity building, and collaborative planning. The difference lies in the implementation strategy, where SMP Negeri 1 Gedangan emphasized curriculum adaptation and resource mapping, while SMP Negeri 4 Sidoarjo focused more on structured professional development and technology-supported learning preparation.

Implementation of learning through the deep learning approach

The implementation of learning through the deep learning approach in both schools emphasized the principles of mindful, meaningful, and joyful learning. Learning activities were designed to encourage students to actively construct knowledge, connect concepts with real-life situations, and engage in reflective learning experiences. Teachers acted not only as knowledge transmitters but also as facilitators who guided students in exploring ideas, solving problems, and developing higher-order thinking skills.

Student engagement was strengthened through contextual learning, group discussions, project-based activities, and collaborative problem-solving. Teachers encouraged students to participate actively through stimulating questions, case-based discussions, and reflective activities. To accommodate diverse learning needs, both schools implemented differentiated instruction by providing scaffolding, modifying learning materials, and adjusting learning processes according to students' abilities and characteristics, including those with special educational needs.

Digital technology also played an important role in supporting deep learning implementation. Teachers utilized digital resources, online learning platforms, coding activities, artificial intelligence-based learning, and various multimedia tools to facilitate deeper understanding and student interaction. These practices were complemented by project-based learning that enabled students to apply knowledge in authentic contexts while developing critical thinking, creativity, communication, and collaboration skills.

The implementation of deep learning was further supported by student affairs programs and school facilities. Character-building activities, extracurricular programs, literacy initiatives, and leadership development programs were integrated to reinforce meaningful learning experiences beyond the classroom. In addition, the availability of digital facilities, laboratories, learning spaces, internet access, and other educational resources contributed significantly to creating a supportive learning environment for deep learning implementation.



Figure 2. Interview with the Principal of SMP Negeri 4 Sidoarjo

Supporting and inhibiting factors of deep learning implementation

The implementation of deep learning in both schools was influenced by various supporting and inhibiting factors. The main supporting factors included leadership commitment, teacher collaboration, professional learning communities, supportive school policies, adequate facilities, digital technology, parental involvement, and active participation from students. Both schools strengthened teacher competencies through professional development activities, internal learning communities, and subject teacher forums such as MGMP and KRIDA, which served as platforms for sharing best practices and solving instructional challenges collaboratively.

In addition, the availability of learning facilities, internet access, digital platforms, and technology-based learning resources supported the implementation of deep learning. School policies that provided teachers with flexibility to innovate in learning design also contributed positively to the development of meaningful and student-centered learning experiences. Support from parents and external stakeholders further strengthened the implementation process through continuous communication and collaborative educational programs.

Despite these strengths, several challenges were identified across both research sites. The most significant barriers were related to teacher readiness in adopting new pedagogical approaches, variations in teachers' understanding of deep learning principles, and difficulties in shifting from traditional teaching practices to learning that promotes critical

and reflective thinking. Student mindset also emerged as a challenge, as some students were still accustomed to memorization-oriented learning and required additional support to develop analytical and independent learning skills.

Other obstacles included limitations in learning time, unequal access to digital facilities, and the need for continuous improvement of technological infrastructure. These findings indicate that successful implementation of deep learning requires not only curriculum transformation but also continuous support for human resources, technology integration, school leadership, and collaborative learning cultures.

Table 1. Cross-site findings on deep learning implementation

Research Focus		Cross-Site Findings
Learning through the Deep Learning Approach	Planning	Both schools integrated the Merdeka Curriculum into the Deep Learning framework through competency mapping, strengthening graduate profile dimensions, teacher capacity development, standardized teaching modules, and supportive leadership policies.
Implementation of Learning through the Deep Learning Approach		Learning implementation emphasized active student engagement, contextual learning, differentiated instruction, character development, digital literacy, project-based learning, and collaboration among teachers, students, and parents.
Inhibiting Factors of Deep Learning Implementation		Major challenges included teacher resistance to pedagogical transformation, students' dependence on rote learning, uneven digital competencies, limited technological facilities, time constraints, and environmental issues affecting the learning climate.
Supporting Factors of Deep Learning Implementation		Supporting factors consisted of strong school leadership, policy support, teacher autonomy, professional learning communities (MGMP and KRIDA), technology integration, adequate facilities, parental involvement, and collaboration with external stakeholders.
Principal Evaluation of Deep Learning Implementation		Evaluation focused on higher-order thinking skills (HOTS), application of knowledge in real-life contexts, student character development, implementation of mindful, meaningful, and joyful learning, and the development of critical and independent learners.
Principal Strategies in Monitoring Deep Learning Implementation		Monitoring was conducted through structured academic supervision, classroom observation, teaching module review, coaching, mentoring, constructive feedback, and dissemination of best practices among teachers.

Principal evaluation of deep learning implementation

The evaluation of deep learning implementation in both schools focused on measuring students' mastery of competencies, learning outcomes, and character development. Success was not solely determined by academic achievement but also by students' ability to apply knowledge in real-life contexts, demonstrate critical thinking skills, and actively participate in the learning process. Higher Order Thinking Skills (HOTS) became one of the primary indicators used to assess the effectiveness of deep learning implementation.

In addition to cognitive achievement, evaluation emphasized the development of student character and the attainment of graduate profile competencies. Both schools assessed students' independence, responsibility, collaboration, creativity, communication skills, and critical reasoning as integral components of learning outcomes. The implementation of deep learning was considered successful when students demonstrated balanced growth in knowledge, skills, and character.

Reflective activities were regularly conducted to identify strengths, challenges, and opportunities for improvement in the learning process. The results of reflection indicated positive changes in student learning behavior, including increased curiosity, active participation, confidence in expressing opinions, and stronger critical thinking abilities. These findings suggest that deep learning contributes not only to academic improvement but also to the holistic development of students in accordance with the expected graduate profile.

Principal monitoring strategies in deep learning implementation

School principals played a central role in monitoring the implementation of deep learning through structured academic supervision and continuous professional support. Monitoring activities were conducted regularly through classroom observations and reviews of teaching documents to ensure that learning practices aligned with deep learning principles. Particular attention was given to student engagement, the depth of learning experiences, and the quality of teaching modules developed by teachers.

In addition to supervision, principals implemented coaching and mentoring strategies to support teachers in addressing instructional challenges. Monitoring results were followed by constructive feedback through clinical discussions that encouraged reflection and continuous improvement. This approach enabled teachers to identify weaknesses, share experiences, and develop more effective learning strategies.

The monitoring process was further strengthened through professional learning communities, including MGMP and the KRIDA Learning Community. These forums provided opportunities for teachers to discuss challenges, exchange best practices, and disseminate successful learning innovations. Through a combination of supervision, coaching, mentoring, feedback, and collaborative learning communities, principals ensured the continuous improvement and sustainability of deep learning implementation in both schools.

Cross-site findings and conceptual model

The cross-site analysis revealed that the successful implementation of deep learning is determined by the interaction of leadership, teacher capacity, curriculum integration, learning resources, and stakeholder collaboration. Both SMP Negeri 1 Gedangan and SMP Negeri 4 Sidoarjo demonstrated a shared commitment to transforming learning through the principles of mindful, meaningful, and joyful learning. Despite differences in implementation strategies, both schools emphasized instructional leadership, professional

development, active student engagement, differentiated instruction, technology integration, and continuous evaluation as essential components of learning management.

The findings indicate that principals play a pivotal role not only as managers but also as instructional leaders who facilitate curriculum transformation, teacher empowerment, and the creation of supportive learning ecosystems. Effective implementation of deep learning requires systematic planning, collaborative implementation, continuous monitoring, and reflective evaluation. Furthermore, the sustainability of deep learning is strengthened through professional learning communities, stakeholder involvement, adequate facilities, and a school culture that encourages innovation and lifelong learning.

Based on the cross-site findings, this study proposes a conceptual model of learning management through a deep learning approach. The model highlights the integration of instructional leadership, teacher professional development, curriculum alignment, digital technology utilization, stakeholder collaboration, and continuous monitoring as key drivers of successful implementation. These elements collectively support the development of students' higher-order thinking skills, character formation, and holistic competencies, ultimately contributing to the achievement of the graduate profile and sustainable educational improvement.

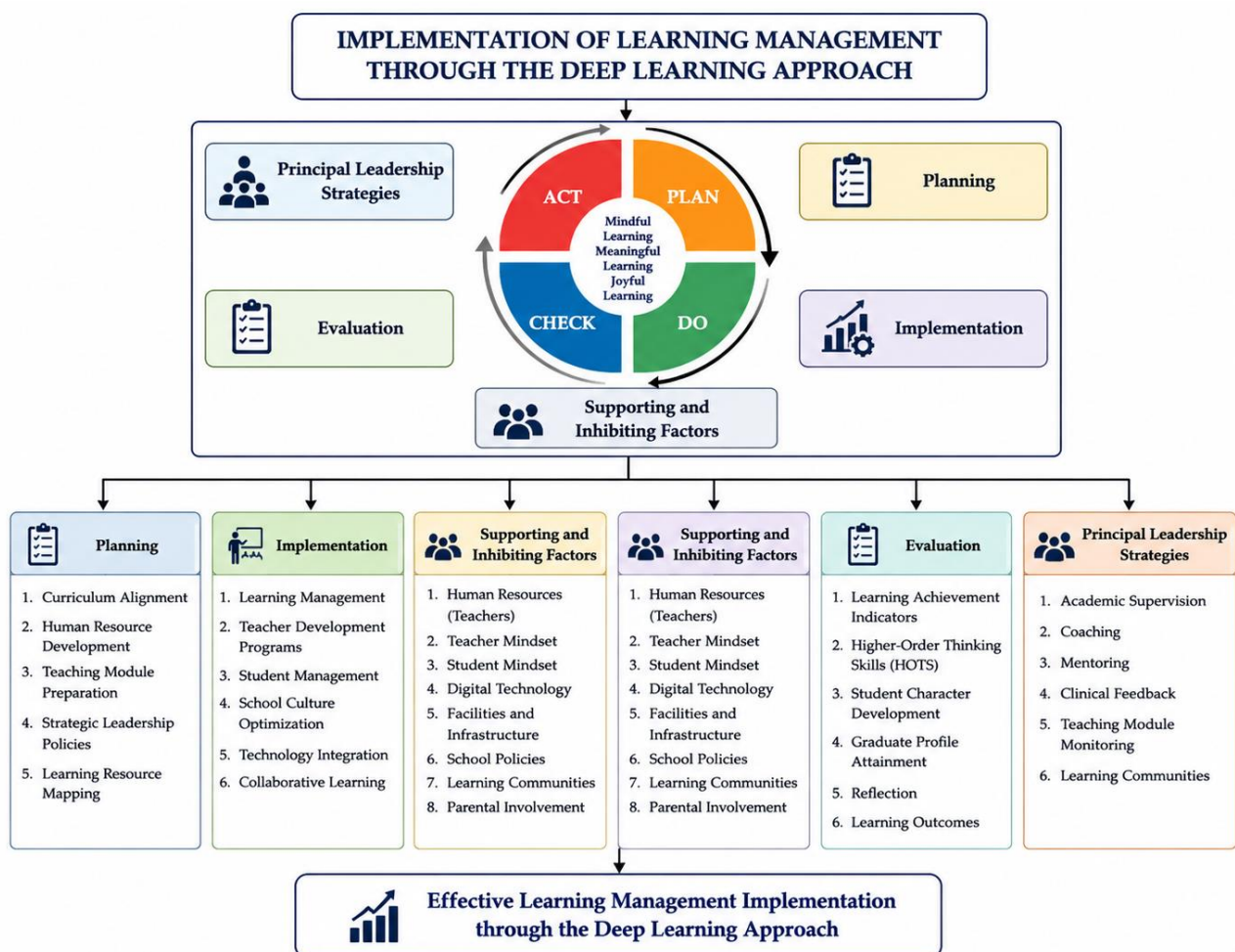


Figure 3. Conceptual model of learning management through the deep learning approach

Discussion

The findings indicate that the successful implementation of deep learning begins with systematic learning management, particularly through curriculum alignment, teacher capacity building, and instructional leadership. Both schools demonstrated that deep learning is not merely a pedagogical strategy but a comprehensive educational transformation that requires structured planning and active stakeholder involvement. These findings support the view that deep learning should be designed through systematic educational planning to promote meaningful understanding and character development among students (Sumarto & Harahap, 2023). Furthermore, the integration of teaching modules, project-based learning, and collaborative professional development confirms the importance of instructional design in creating meaningful learning experiences (Rahmandani et al., 2025; Syarifah et al., 2021).

The implementation stage revealed that teacher transformation from knowledge transmitter to learning facilitator plays a crucial role in fostering mindful, meaningful, and joyful learning. The use of differentiated instruction, scaffolding, project-based learning, and digital technology encouraged students to develop critical thinking, collaboration, and problem-solving skills. These findings are consistent with previous studies emphasizing that deep learning requires active student engagement, strong teacher competence, and supportive learning ecosystems to facilitate deeper conceptual understanding (Saputra et al., 2025; Nurjanah & Suryadi, 2025; Rifayanti & Kaliwanovia, 2025). However, challenges related to teacher mindset, student learning habits, and technological infrastructure remain significant barriers that require continuous institutional support and professional development.

Another important finding concerns the strategic role of principals as transformational and instructional leaders. The study demonstrates that academic supervision, coaching, mentoring, clinical feedback, and professional learning communities are essential mechanisms for ensuring the sustainability of deep learning implementation. Effective leadership enables schools to strengthen teacher professionalism, optimize learning resources, and create collaborative educational ecosystems involving families and external stakeholders. This finding reinforces previous research suggesting that school leadership is a determining factor in translating educational policy into meaningful classroom practice and sustainable learning improvement (Anwar & Sodik, 2025; Nugraha & Hasanah, 2021; Prakoso et al., 2026). Ultimately, the conceptual model proposed in this study highlights that the integration of instructional leadership, teacher empowerment, stakeholder collaboration, and continuous evaluation forms the foundation for developing students' higher-order thinking skills, metacognitive independence, and character development through the deep learning approach.

From the perspective of Sustainable Development Goal (SDG) 4, the findings demonstrate that effective learning management through a deep learning approach extends beyond

improving classroom practices to strengthening the overall quality of education. The integration of instructional leadership, teacher professional development, curriculum transformation, digital learning support, and stakeholder collaboration creates conditions that promote inclusive, equitable, and high-quality learning experiences. By fostering higher-order thinking skills, learner autonomy, collaboration, and continuous professional growth among teachers, the proposed conceptual model contributes to the realization of SDG 4, particularly in enhancing educational quality and preparing students with the competencies needed to participate effectively in an increasingly complex and sustainable society.

CONCLUSION

Fundamental Finding: This study found that the successful implementation of learning management through the deep learning approach is determined by the integration of transformational instructional leadership, adaptive curriculum planning, teacher professional development, and stakeholder collaboration. Deep learning was effectively implemented through the principles of mindful, meaningful, and joyful learning, supported by differentiated instruction, project-based learning, digital technology integration, and professional learning communities. The findings also reveal that school principals play a strategic role not only as managers but also as instructional leaders who facilitate teacher growth through supervision, coaching, mentoring, and continuous monitoring. As a result, deep learning contributes to the development of higher-order thinking skills (HOTS), metacognitive independence, and student character development. **Implication:** The findings provide both theoretical and practical implications. Theoretically, this study extends the perspective of transformational leadership by emphasizing the role of principals as facilitators of teacher professionalism and managers of collaborative learning ecosystems. Practically, the study highlights the importance of strengthening teacher capacity, integrating digital technology, optimizing professional learning communities, and fostering collaboration among schools, families, and external stakeholders to support sustainable deep learning implementation. These strategies also contribute to the achievement of Sustainable Development Goal (SDG) 4 by promoting inclusive, equitable, and high-quality education, strengthening teacher effectiveness, and fostering the development of students' higher-order thinking skills and lifelong learning competencies. **Limitation:** This study was limited to two public junior high schools in Sidoarjo Regency that had already initiated deep learning implementation. Therefore, the findings may not fully represent schools with different organizational characteristics, leadership capacities, or resource availability. In addition, the qualitative case study design focused on in-depth exploration rather than broad generalization. **Future Research:** Future studies are recommended to examine the long-term impact of deep learning on students' academic achievement, metacognitive development, and career readiness through longitudinal research designs. Further research may also investigate the effectiveness of artificial intelligence (AI), digital learning environments, and innovative assessment models in strengthening deep learning practices across different educational levels and contexts.

AUTHOR CONTRIBUTIONS

Aris Setiawan contributed to the conceptualization of the study, research design, data collection, field investigation, data curation, formal analysis, interpretation of findings, visualization, and manuscript drafting. **Yatim Riyanto** contributed to the conceptual framework, research supervision, methodology validation, critical review of the manuscript, and refinement of the theoretical foundation. **Nunuk Hariyati** contributed to research supervision, methodology development, validation of findings, critical manuscript review, and overall improvement of the academic quality of the article. All authors have read, reviewed, and approved the final version of the manuscript for submission.

CONFLICT OF INTEREST STATEMENT

The authors state that no financial or personal conflicts of interest exist that may have affected the content or findings of this research.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including OpenAI ChatGPT, as support during the language refinement, editing, formatting, and manuscript development stages of this article. ChatGPT was utilized to assist in improving the clarity of academic writing, language structure, and organization of the manuscript. All outputs generated with digital assistance were carefully reviewed, verified, revised, and interpreted by the authors to ensure accuracy, originality, academic integrity, and compliance with scholarly standards. The authors take full responsibility for the content, analysis, interpretations, and conclusions presented in this manuscript.

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