UJME 14 (2) 2025: 98-105
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/journals/ujme
ISSN: 2252-6927 (print); 2460-5840 (online)

Exploration of the Implementation of Deep Learning Approach in Teaching Mathematics in Secondary Schools

Fitria Pujawati[a,*], M. Naufal Azkia[a], Wati Susilawati[a]

[a] *Tarbiyah and Teacher Training Departement, Universitas Islam Negeri Sunan Gunung Djati, Bandung 40292, Indonesia*

* *E-mail address: fitriapujawati97@gmail.com*

ARTICLE INFO

Article history:
Received 11 June 2025
Received in revised form 5 August 2025
Accepted 7 August 2025

Keywords:
Deep learning; mathematics education; teacher perception; instructional strategy; implementation challenges.

Abstract

This study explored how mathematics teachers interpret and implement deep learning approaches in classroom instruction and the challenges they encounter. Using a qualitative case study design, data were collected from five teachers through an open-ended online questionnaire and two in-depth interviews. Thematic analysis was conducted following the Miles, Huberman, and Saldaña framework. The findings revealed that teachers view deep learning as a student-centered approach that emphasizes conceptual understanding, critical thinking, and emotional engagement. Teachers employ various strategies such as group discussions, problem-based learning, contextual problem solving, discovery learning, open-ended math projects, game-based assessments, and the CORE model. However, challenges arose in tailoring strategies to meet diverse student needs, managing time constraints, and dealing with limited infrastructure. The study concludes that, although teachers value deep learning, its effective classroom application depends on stronger institutional support and flexible pedagogical models. These findings offer practical insights into how deep learning is interpreted and practiced in Indonesian mathematics classrooms.

1. Introduction

In today’s rapidly evolving and interconnected world, education systems face mounting pressure to transcend rote memorization and cultivate students' critical thinking, adaptability, and problem-solving competencies. This imperative is particularly pronounced in mathematics education, where traditional instructional methods, often limited to formulaic drills and procedural repetition, remain pervasive despite ongoing curriculum reform efforts.

The necessity of deep learning in mathematics is well-documented. Extensive research has underscored the inadequacies of superficial instruction, advocating instead for pedagogical approaches that foster conceptual understanding, meaningful engagement, and knowledge transfer (Hiebert & Grouws, 2007; Rittle-Johnson, Schneider, & Star, 2017). Scholars such as Boaler (2016) emphasize the importance of student-centered learning environments that encourage active knowledge construction, the making of conceptual connections, and engagement with authentic problem-solving situations. In alignment with these perspectives, Indonesia’s Ministry of Education, Culture, Research, and Technology has introduced the Merdeka Curriculum, a policy initiative that promotes deep learning pedagogies by prioritizing understanding over memorization and encouraging contextualized, learner-driven instruction.

Although the theoretical and policy discourse surrounding deep learning continues to gain traction, the gap between policy and practice remains considerable, particularly in the Indonesian context. While international studies have examined elements such as productive struggle (Kapur, 2016) and trans disciplinary inquiry (Sriraman & English, 2010), few have explored how these approaches are practically interpreted and enacted by mathematics teachers in classrooms. At the national level, educational research in Indonesia has primarily focused on general innovations in instruction, such as inquiry-based or problem-

To cite this article:
Pujawati, F., Azkia, M. N., & Susilawati, W. (2025). Exploration of the Implementation of Deep Learning Approach in Teaching Mathematics in Secondary Schools. *Unnes Journal of Mathematics Education*, *14*(2), 98-105. https://doi.org/10.15294/ujme.v14i2.27374

based learning (Widodo & Wahyudin, 2018; Astuti & Suryadi, 2021), but has yet to develop an in-depth empirical understanding of deep learning as a comprehensive pedagogical approach.

This paucity of grounded research has created a pressing knowledge gap. Despite policy directives that promote deep learning, there is limited evidence of how teachers perceive, adapt, or struggle to implement this approach in the field. A recent systematic literature review by Aminullah (2024), encompassing more than 300 studies, further confirmed this deficiency, as only a negligible number of publications directly addressed deep learning in the context of mathematics instruction in Indonesian secondary schools.

To address this gap, the present study explores how mathematics teachers across diverse school types and educational levels, including SMP/MTs, SMA/MA, and SMK, from two provinces (Banten and West Java), conceptualize and implement the deep learning approach. The study does not restrict its focus to *Sekolah Penggerak* alone, but instead embraces a wider sample to better capture how deep learning is understood and applied within various instructional environments, including urban and semi-urban schools.

Specifically, this study aims to: (1) investigate teachers' perceptions of the deep learning approach in mathematics education, (2) analyze the instructional strategies they employ to align with deep learning principles, and (3) identify the barriers and challenges they encounter in implementing this approach. Data were collected through an open-ended online questionnaire and follow-up interviews with selected participants.

By foregrounding the lived experiences of teachers, this study makes both a scientific and practical contribution. It fills a significant empirical void by offering insight into how deep learning is actually understood and operationalized in the classroom. At the same time, it provides actionable evidence that can inform future teacher training programs, instructional design, and policy development aimed at strengthening the alignment between curriculum reform and classroom practice, not only in Indonesia but in similar developing educational contexts worldwide.

2. Methods

This qualitative research was conducted between March and May 2025 with the objective of exploring how mathematics teachers interpret and implement the deep learning approach within secondary school classrooms. A case study design was employed to gain an in-depth understanding of teacher perspectives, instructional strategies, and challenges encountered during the implementation of this approach.

Participants in this study consisted of five mathematics teachers from two Indonesian provinces, Banten and West Java, representing various school levels (SMP/MTs, SMA/MA, and SMK) and school settings (urban and semi-urban). For the online questionnaire, participants were recruited through open, voluntary participation. The researcher distributed a Google Form link without specific sampling restrictions, allowing any eligible mathematics teacher who received the form to participate. This approach ensured inclusivity and encouraged diverse contributions while maintaining alignment with ethical principles of informed and voluntary participation.

For the follow-up interviews, participants were selected using purposive sampling. Two teachers, both from the senior secondary level (SMA), representing urban and semi-urban schools, were chosen based on their willingness to be interviewed and the depth of insight shown in their questionnaire responses. This sampling approach ensured that interviewees could provide rich, relevant, and reflective data to support the research focus. The data collection was conducted fully online, using two instruments:

- A Google Form-based questionnaire, which included 10 open-ended questions designed to explore three key dimensions: (1) teachers' perceptions of the deep learning approach, (2) the strategies they apply in mathematics instruction, and (3) the challenges they encounter in the classroom. The questionnaire allowed participants to elaborate their responses narratively and upload relevant supporting documents.
- Two follow-up interviews were conducted with selected participants via WhatsApp video call. These were mathematics teachers from senior secondary schools (SMA)—one from an urban setting and the other from a semi-urban school. Each interview used a semi-structured protocol consisting of 10 open-ended prompts, enabling the researcher to clarify and deepen responses provided in the questionnaire. Interviews lasted approximately 30–40 minutes and were recorded with participant consent.

Data were analyzed using the interactive approach of qualitative analysis proposed by Miles, Huberman, and Saldaña (2014). The process involved three major concurrent flows of activity: data condensation, data display, and drawing and verifying conclusions. The researchers condensed raw data from questionnaires and interviews into initial codes, organized them into themes using a matrix in Microsoft Excel, and synthesized findings to construct patterns and relationships among the data.

To strengthen the trustworthiness of the study, methodological triangulation was applied by integrating data from questionnaires, interviews, and uploaded teaching documents. A member checking procedure was conducted, where initial thematic summaries were returned to two participants for verification and feedback. This helped ensure that the interpretations accurately represented participants' intended meanings.

All ethical considerations were upheld. Participants were informed about the purpose of the study, the voluntary nature of participation, and the confidentiality of their responses. Informed consent was obtained via the introductory section of the Google Form and was verbally reiterated prior to each interview. No identifying data were disclosed in the final report.

This methodology provides a clear and detailed foundation for replicability and reliability, particularly for researchers interested in evaluating the practical realities of pedagogical reform initiatives in similar developing country contexts.

3. Results & Discussions

This section presents findings organized into three main themes aligned with the research questions: (1) teachers' perceptions of the deep learning approach, (2) instructional strategies applied, and (3) challenges in implementation. The data were analyzed using the interactive approach of Miles, Huberman, and Saldaña (2014), which includes data condensation, data display, and conclusion drawing. Insights were drawn from both online questionnaires and follow-up interviews with two secondary school mathematics teachers.

3.1. Teachers' Perceptions of Deep Learning in Mathematics Education

The seven participants in this study shared thoughtful and varied perspectives on the meaning of deep learning in mathematics. Their responses centered around key themes such as conceptual understanding, student-centeredness, emotional engagement, and reflection. Table 1 summarizes the perceptions of all participants.

Table 1. Teachers' Perceptions of Deep Learning

Respondent	Perception Summary
R1	Emphasizes student understanding and mental engagement
R2	Highlights connections between knowledge and real-world contexts
R3	Reflective, contextual, promotes student questioning
R4	Focuses on long-term learning, exploration, and motivation
R5	Encourages critical and independent thinking through inquiry
Teacher A	Deep learning is mindful, meaningful, and joyful
Teacher B	Deep learning ensures emotional and psychological safety in cognitive growth

R1 described deep learning as *a process that engages students mentally and conceptually*, prioritizing their ability to understand rather than memorize. This reflects Boaler's (2016) assertion that mathematics classrooms should promote student identity and empowerment, not just procedural fluency. Similarly, Hiebert and Grouws (2007) argue that understanding mathematical structure requires attention to how students make sense of problems. Rittle-Johnson et al. (2017) further emphasize that conceptual understanding precedes procedural mastery. Fan and Miao (2019) support this view by promoting instructional variation to deepen student thinking. Thus, R1's conception aligns with research that equates deep learning with cognitive ownership and internalization.

R2 saw deep learning as connecting knowledge to real-life context, allowing students to see relevance and applicability. This is echoed in Xie et al. (2020), who designed intelligent classroom approaches to bridge school knowledge and practical situations. Kapur (2016) also describes productive struggle as essential when students connect prior knowledge with new challenges. According to Widodo and Wahyudin (2018), contextualized learning fosters students' curiosity and persistence. Tian et al. (2022) found that real-world applications in primary math classes increased conceptual retention. Zhen (2022) complements this by linking innovation in math teaching to learners' capacity to transfer knowledge beyond the classroom.

R3 emphasized reflection and questioning, suggesting that students are encouraged to ask “why” and “how” in mathematics. This mirrors Biggs and Tang (2011), who claim that reflective learners become adaptive learners. Reinholz and Shah (2018) highlight that classrooms that promote discourse and inquiry tend to enhance equitable participation. Sriraman and English (2010) argue that transdisciplinary inquiry fosters creative reflection. Sun and Li (2018) confirm that reflection in deep learning environments nurtures stronger conceptual linkage. Prediger and Roos (2023) also describe how language and mathematical discourse support deeper sense-making, underpinning R3’s viewpoint.

R4 linked deep learning with sustained engagement and exploration, a long-term process rather than immediate outcomes. This aligns with the longitudinal framing of deep learning found in the work of Demir and Karaboğa (2021), where deep learning approaches improve achievement when sustained over time. Boaler (2016) reiterates that math education should move from task completion to curiosity-driven discovery. Astuti and Suryadi (2021) found that inquiry-based learning supports student exploration in the Indonesian context. Rittle-Johnson et al. (2017) assert that deep conceptual change takes time, necessitating cumulative design. These insights all reinforce R4’s emphasis on durable learning.

R5 focused on critical and independent thinking, signaling a shift from teacher-centered explanation to student-initiated reasoning. This perspective is strongly supported by Kapur (2016), who found that students learn better when they engage with problems without immediate solutions. Orhani (2024) emphasized the role of exploration and self-questioning in mathematical thinking. Fauskanger and Bjuland (2018) analyzed teacher discourses and noted the growing push toward independence and conceptual flexibility. Hiebert and Grouws (2007) similarly stress tasks that require making connections between ideas. Fan and Miao (2019) found that variation and challenge are key to fostering independent mathematical thought.

Teacher A provided a nuanced articulation, defining deep learning as *mindful, meaningful, and joyful*. This composite reflects what Boaler (2016) frames as “mathematical mindsets,” where joy and persistence go hand-in-hand. Biggs and Tang (2011) point out that affective engagement (joy and mindfulness) contributes to metacognitive control. According to Sriraman and English (2010), holistic environments promote both emotion and cognition. Kapur (2016) contends that challenge and joy can coexist when students are supported in their struggle. Moreover, Reinholz and Shah (2018) warn that affective exclusion leads to disengagement, thus validating the inclusion of joy in learning design.

Teacher B centered deep learning on emotional safety and well-being, positioning it as a prerequisite for intellectual engagement. This matches Zhen’s (2022) study on socio-affective environments in math education. Sun and Li (2018) found that cognitive performance improves in emotionally safe classrooms. Fan and Miao (2019) argue that safe spaces allow learners to take intellectual risks. Widodo and Wahyudin (2018) note that trust and psychological comfort are essential in open-ended tasks. Lastly, Prediger and Roos (2023) underscore that affective context shapes how students interact with mathematical meaning. Teacher B thus contributes a rarely-emphasized yet crucial emotional dimension to deep learning in math.

3.2. Instructional Strategies for Deep Learning

Teachers in this study demonstrated thoughtful adaptations of their pedagogical strategies to align with deep learning principles. These strategies were characterized by their emphasis on student engagement, real-world application, and exploratory learning. Table 2 presents a summary of the strategies employed by each respondent.

Table 2. Instructional Strategies Reported by Teachers

Respondent	Instructional Strategy
R1	Group discussions, structured questioning, and individual presentations
R2	Problem-based learning (PBL) using local contexts
R3	Contextual problem solving, peer collaboration, reflective dialogue
R4	Discovery learning, scaffolded tasks, and guided inquiry
R5	Use of open-ended math projects and formative feedback loops
Teacher A	Game-based assessments integrated with student interests
Teacher B	CORE model (Connecting, Organizing, Reflecting, Extending) anchored in real-life math

R1 employed group discussions and structured questioning, creating space for student articulation of thought. This reflects the principles of dialogic teaching, as described by Reinholz and Shah (2018), who argue that classroom dialogue fosters equity and conceptual clarity. According to Boaler (2016), discussion enhances student voice and builds identity in mathematics. Fan and Miao (2019) highlight variation in discussion formats to deepen understanding. Rittle-Johnson et al. (2017) demonstrate that structured questioning supports integration of procedural and conceptual knowledge. Widodo and Wahyudin (2018) also confirm that collaborative tasks improve reasoning in Indonesian classrooms.

R2 adopted problem-based learning (PBL) rooted in local contexts, enabling students to connect math to their immediate environment. This strategy aligns with Tian et al. (2022), who reported that PBL enhances deep learning by engaging students in inquiry tied to authentic issues. Kapur (2016) emphasized the productive struggle students encounter in context-rich tasks, which leads to durable understanding. Xie et al. (2020) argue that real-world relevance activates prior knowledge, making new learning more meaningful. Sriraman and English (2010) further suggest that embedding math in societal contexts strengthens interdisciplinary connections. Fauskanger and Bjuland (2018) observed that teachers' PBL practices are informed by their beliefs in student autonomy and relevance.

R3 emphasized peer collaboration and reflective dialogue, facilitating a co-constructivist environment. This strategy echoes Sun and Li (2018), who emphasized peer explanation as a driver of conceptual transfer. According to Boaler (2016), collaboration in math develops critical reasoning and persistence. Prediger and Roos (2023) note that group work in math enhances language and cognitive scaffolding. Zhen (2022) supports structured peer interactions to promote active engagement and reduce math anxiety. Fan and Miao (2019) confirm that variation in peer structures supports differentiated learning paths and cognitive diversity.

R4 used scaffolded discovery learning, supporting students to independently uncover mathematical relationships. This resonates with Biggs and Tang (2011), who advocate for constructivist environments that gradually shift control from teacher to learner. Kapur (2016) contends that discovery, paired with support, leads to productive struggle and conceptual gain. Rittle-Johnson et al. (2017) argue that problem generation and explanation tasks produce deeper understanding. Demir and Karaboğa (2021) observed that scaffolding enhances outcomes in deep learning-based math instruction. Widodo and Wahyudin (2018) noted discovery-based learning as an effective local approach in Indonesian middle schools.

R5 designed open-ended math projects with formative feedback loops, allowing students to explore problems with multiple solutions and revisit their reasoning. This reflects Zhen (2022), who emphasized innovation and openness in deep learning tasks. Boaler (2016) asserts that non-linear project work fosters persistence and identity development. Fan and Miao (2019) describe how open tasks allow deeper student inquiry and ownership. Astuti and Suryadi (2021) confirm that formative feedback supports self-regulated learning in Indonesian math education. Xie et al. (2020) also noted that feedback-integrated projects lead to stronger retention in smart classrooms.

Teacher A integrated game-based assessments tailored to student interests, making evaluation enjoyable and student-driven. This aligns with Kapur (2016), who supports “low-stakes struggle” environments to reduce performance anxiety. Zhen (2022) found that gamified learning increased engagement and performance in abstract math topics. Sun and Li (2018) suggest that games foster collaboration and competition, driving motivation. Boaler (2016) emphasizes that creative tasks make math more accessible and joyful. Demir and Karaboğa (2021) argue that affective elements in instruction, such as enjoyment, enhance cognitive outcomes in deep learning approaches.

Teacher B implemented the CORE approach, guiding students through stages of connecting concepts, organizing ideas, reflecting on outcomes, and extending learning to new contexts. This structured approach supports the deep learning cycle described by Miles et al. (2014). Prediger and Roos (2023) affirm that such frameworks promote language-rich and cognitively demanding tasks. Fan and Miao (2019) endorse approaches that scaffold transitions from surface to deep learning through reflection. Orhani (2024) highlights the power of structured inquiry in math to foster durable understanding. Reinholz and Shah (2018) point out that such cycles encourage inclusive participation and clarity in conceptual dialogue.

3.3. Challenges in Implementing Deep Learning

While teachers showed clear understanding and intent to apply deep learning strategies, they encountered a range of practical and structural challenges. These include diverse student readiness, time constraints, inflexible content, and lack of supporting infrastructure. Table 3 presents the barriers reported by each participant.

Table 3. Challenges in Implementing Deep Learning

Respondent	Challenge Description
R1	Students struggle with independent learning and self-direction
R2	Limited classroom time to balance exploration and content coverage
R3	Variation in student ability makes depth of instruction uneven
R4	Adapting new methods with minimal instructional guidance or training
R5	Infrastructure gaps such as internet and multimedia tools in semi-urban contexts
Teacher A	Difficulty selecting the right strategy for heterogeneous student profiles
Teacher B	Certain math topics are hard to adapt to deep learning principles

R1 noted that students lack readiness for independent learning, making it difficult to initiate deep, exploratory tasks. This is consistent with findings by Demir and Karaboğa (2021), who highlight the need for prior scaffolding before implementing deep learning. Kapur (2016) warned that unprepared students may experience unproductive struggle when facing ill-structured problems. Xie et al. (2020) emphasize that foundational skills and mindset are prerequisites for meaningful engagement. Rittle-Johnson et al. (2017) suggest that self-direction in math requires metacognitive development. Widodo and Wahyudin (2018) similarly argue for staged introduction of autonomy in Indonesian classrooms.

R2 struggled with time constraints, particularly in balancing content completion with conceptual exploration. This reflects the systemic issue identified by Boaler (2016), who criticizes rigid pacing guides that constrain depth. Fan and Miao (2019) argue that deep learning requires extended time for investigation and reflection. Biggs and Tang (2011) recommend restructuring instructional design to prioritize depth over coverage. Zhen (2022) noted that real-world math teaching innovation often clashes with curricular time demands. Astuti and Suryadi (2021) echoed that Indonesian teachers often prioritize exam preparation, reducing time for exploratory learning.

R3 cited student ability gaps as a major challenge in maintaining lesson depth. According to Prediger and Roos (2023), wide ability ranges affect the pacing and scaffolding of mathematical discourse. Reinholz and Shah (2018) point out that differentiated tasks require more planning and classroom support. Tian et al. (2022) note that deep learning classrooms must adapt tasks to student diversity. Sriraman and English (2010) suggest using tiered activities to accommodate different learners. Orhani (2024) proposes differentiated approaching and problem types to address equity in depth.

R4 reported lack of training or guidance in applying deep learning. This aligns with Zhen (2022), who observed that teachers often apply deep learning superficially due to limited understanding. Demir and Karaboğa (2021) argue that teacher professional development is crucial for sustaining deep approaches. Kapur (2016) warns that without support, teachers may revert to traditional methods. Boaler (2016) emphasizes the need for communities of practice in math innovation. Fauskanger and Bjuland (2018) recommend mentoring structures to help teachers internalize deep learning principles.

R5 experienced infrastructure limitations, such as lack of devices, poor internet access, and minimal visual aids. These constraints are frequently reported in developing country contexts. Xie et al. (2020) underscore that intelligent learning environments are dependent on digital infrastructure. Sun and Li (2018) argue that without technological tools, deep learning loses interactivity. Fan and Miao (2019) highlight the role of media in enhancing conceptual variation. Widodo and Wahyudin (2018) confirm that Indonesian rural and semi-urban schools often face digital divide issues. Zhen (2022) suggests that sustainable infrastructure must precede pedagogical transformation.

Teacher A faced challenges in selecting strategies aligned with students’ learning profiles. This complexity is supported by Biggs and Tang (2011), who argue that constructive alignment must consider learner variability. Rittle-Johnson et al. (2017) explain that tailoring instruction requires ongoing assessment and adaptive planning. Sriraman and English (2010) propose flexible frameworks that allow real-time instructional adjustment. Fan and Miao (2019) stress that deep learning must be contextualized to learner background. Boaler (2016) adds that rigid application of strategies can be counterproductive without responsiveness.

Teacher B noted that not all math topics align naturally with deep learning, especially abstract or algorithm-heavy content. This point is supported by Kapur (2016), who found that some content areas resist inquiry without substantial redesign. Prediger and Roos (2023) argue that topic structure influences task design feasibility. Fauskanger and Bjuland (2018) suggest mapping deep learning potential per topic to guide teachers. Orhani (2024) advises against forcing deep learning into formats that do not support reflection. Tian et al. (2022) propose hybrid approaches where surface and deep learning can coexist depending on topic demands.

4. Conclusion

This study explored how mathematics teachers perceive and implement deep learning as a pedagogical approach, and what challenges they encounter in the process. In response to the first research question, the findings showed that teachers understood deep learning not only as a cognitive process involving conceptual understanding and reflective thinking, but also as an affective experience emphasizing student well-being and engagement. Addressing the second question, Teachers implement various strategies such as group discussion, problem-based learning, contextual problem solving, discovery learning, use of open-ended math projects, game-based assessments, and the CORE model, tailored to encourage active and meaningful student participation. The third question revealed that teachers faced considerable constraints, including infrastructure limitations, lack of time, and student unpreparedness. These findings reflect both enthusiasm and cautious realism, pointing to a need for professional support, curriculum flexibility, and content-specific guidance. Ultimately, this research highlights the contextual complexity of implementing deep learning in mathematics education and the practical considerations that shape its classroom application.

References

Boaler, J. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. Jossey-Bass.

Demir, I., & Karaboğa, H. A. (2021). Modeling mathematics achievement with deep learning methods. SIGMA Journal, 39(2), 311–324. https://doi.org/10.14744/sigma.2021.00030

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). Qualitative data analysis: A methods sourcebook (3rd ed.). Sage.

Orhani, S. (2024). Deep learning in math education. Retrieved from https://www.researchgate.net/publication/380168309

Tian, X., Zhao, J., & Nguyen, K. T. (2022). Practical research on primary mathematics teaching based on deep learning. Journal of Mathematics Education, 2022, 7899180. https://doi.org/10.1155/2022/7899180

Xie, Y., Li, J., Ye, Z., Lin, X., & Cao, L. (2020). Deep-learning classroom approaches in intelligent environments. IEEE, 9215521. https://ieeexplore.ieee.org/document/9215521

Zhen, L. (2022). Innovative math teaching based on deep learning algorithms. Education and Information Technologies, 27, 1575–1591.

Fauskanger, J., & Bjuland, R. (2018). Deep learning in teachers' discourses. European Journal of Teacher Education, 41(5), 621–636. https://doi.org/10.1080/02619768.2018.1523391

Sun, Y., & Li, Q. (2018). Application of deep learning in mathematical education. IEEE Conference Proceedings, 8569052.

Prediger, S., & Roos, A. K. (2023). Deeper learning in mathematics. Springer. https://doi.org/10.1007/978-3-031-10268-6

Widodo, S. A., & Wahyudin, W. (2018). Selection of learning approaches for creative thinking in math. International Journal of Instruction, 11(3), 729–742.

Astuti, S. W., & Suryadi, D. (2021). Inquiry-based learning to enhance mathematical reasoning. Jurnal Pendidikan Matematika, 12(2), 85–95.

Kapur, M. (2016). Productive failure in learning math. Educational Psychologist, 51(2), 289–299. https://doi.org/10.1080/00461520.2016.1155457

Sriraman, B., & English, L. D. (2010). Transdisciplinary approaches in math education. ZDM Mathematics Education, 42(1), 51–54.

Sutarto, H., Sari, D. P., & Handayani, N. D. (2022). Challenges in implementing the Merdeka curriculum. Jurnal Pendidikan Indonesia, 11(1), 1–10. https://doi.org/10.23887/jpi-undiksha.v11i1.42222

Hiebert, J., & Grouws, D. A. (2007). Effects of math teaching on learning. In F. K. Lester (Ed.), Second handbook of research on mathematics teaching and learning (pp. 371–404). IAP.

Rittle-Johnson, B., Schneider, M., & Star, J. R. (2017). Conceptual and procedural knowledge. Educational Psychology Review, 29, 581–604.

Biggs, J., & Tang, C. (2011). Teaching for quality learning at university (4th ed.). Open University Press.

Fan, L., & Miao, Z. (2019). Teaching with variation for deep learning. ZDM Mathematics Education, 51(1), 49–63.

Reinholz, D. L., & Shah, N. (2018). Equity in math classroom participation. Journal for Research in Mathematics Education, 49(4), 452–464.Jawa Tengah (Decree of the Governor of Central Java Number 17, 2015 on Second Amendment to The Decree of the Governor of Central Java Number 39, 2008)