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Discovery Learning Integrated with Local Potential in Enhancing Computational Thinking: A Systematic Literature Review on Heat and Temperature Learning

Danang Risfaldy[1*], Didik Setyawarno[2]

[1] Science Education Program, Universitas Negeri Yogyakarta, Indonesia
[2] Department of Science Education, Universitas Negeri Yogyakarta, Indonesia

*Email Correspondence: danangrisfaldy.2022@student.uny.ac.id

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ABSTRACT
This study presents a systematic literature review (SLR) aimed at synthesizing research findings on the integration of Discovery Learning with local potential to support the development of Computational Thinking (CT) in heat and temperature learning. The review followed Kitchenham's SLR framework, including the formulation of research questions, search strategy, study selection, and data synthesis. The literature search was conducted using Google Scholar through the Publish or Perish tool with the keywords "Discovery Learning, Local Potential, and Computational Thinking" within the publication range of 2018–2025. A total of 200 articles were initially identified. After the screening process, 20 articles remained, which were further evaluated through eligibility assessment, resulting in 14 relevant studies. Following a full-text review and relevance to Computational Thinking, seven articles were included in the final synthesis. The findings reveal a consistent pattern indicating that Discovery Learning, both independently and when integrated with local potential, contributes to the development of students' Computational Thinking skills. The integration of local potential enhances contextual understanding and student engagement. In heat and temperature learning, activities such as data analysis, pattern recognition, and experimentation align with key components of CT, including decomposition, abstraction, and algorithmic thinking. However, the review identifies several research gaps, including the limited number of studies explicitly integrating Discovery Learning, local potential, and CT, as well as the lack of structured instructional designs and assessment tools targeting CT indicators. This study highlights the importance of contextualized Discovery Learning as a strategic approach to foster Computational Thinking in science education and recommends further empirical research to strengthen its implementation.

1. INTRODUCTION

Indonesian students' capacity to optimally adopt and use this technology is still insufficient (Firdaus & Nurohman, 2025). The transformation of education in the era of the Industrial Revolution 4.0 requires students to be equipped with essential 21st-century skills. These competencies are commonly conceptualized as the 4C skills, including collaboration, critical thinking, creativity, and communication (Marta Putra & Nurlizawati, 2019). Among these competencies, Computational Thinking (CT) has emerged as a fundamental skill that supports problem-solving, logical reasoning, and the ability to address complex challenges in various disciplines (Putri, 2024). CT is defined as a cognitive process involving problem decomposition, system design, and understanding complex phenomena (Wing, 2006). It encompasses four core components: decomposition, pattern recognition, abstraction, and

*Corresponding author
E-mail addresses: danangrisfaldy.2022@student.uny.ac.id

algorithmic thinking, which collectively enable learners to approach problems systematically and efficiently (Setiawan et al., 2023).

The integration of Computational Thinking into science learning is particularly relevant in physics, where students are required to analyze data, identify patterns, and construct conceptual generalizations. In the context of heat and temperature, CT is reflected in students' ability to interpret temperature measurements, recognize patterns of thermal change, and model heat transfer phenomena (Setiawan et al., 2023). These processes align closely with the fundamental components of CT, making this topic a suitable domain for its development. Furthermore, CT plays a crucial role in enhancing students' analytical and problem-solving abilities in physics learning (Rosandhi & Haryadi, 2024). Despite its relevance, students often perceive heat and temperature as abstract and difficult concepts, leading to limited conceptual understanding (Ningsih et al., 2022). At the same time, thermal phenomena are closely related to everyday experiences, indicating the need for contextualized learning approaches that bridge abstract concepts with real-life situations (Setiawan et al., 2023).

Discovery Learning has been widely recognized as an instructional model that promotes active learning and and influences motivation, metacognition, and engagement (Djara et al., 2025; Firdaus et al., 2025). This model encourages students to explore, investigate, and construct knowledge independently through systematic inquiry processes (Ningsih et al., 2022). Previous studies have demonstrated that Discovery Learning can positively influence conceptual understanding and computational skills (Hapsari et al., 2025). Through its learning stages, such as stimulation, problem identification, data collection, and verification, Discovery Learning provides opportunities for students to engage in processes that are closely aligned with CT components, including decomposition, pattern recognition, abstraction, and algorithmic reasoning.

The effectiveness of Discovery Learning can be further enhanced when learning is contextualized using local potential. Contextual learning grounded in local environments allows students to connect scientific concepts with familiar phenomena, thereby improving engagement and conceptual understanding (Firda et al., 2023). The integration of local potential not only enriches learning experiences but also serves as a meaningful context for developing CT skills, as students are encouraged to analyze real-world problems, identify patterns, and construct solutions based on their immediate environment.

Despite the growing body of research on Discovery Learning, local potential, and Computational Thinking, studies that explicitly integrate these three components remain limited. Existing research tends to examine these variables separately or does not explicitly measure CT indicators in science learning contexts. In addition, there is still a lack of systematic synthesis that identifies patterns, consistencies, and gaps in previous findings, particularly in the context of heat and temperature learning.

This gap highlights the need for a systematic literature review to provide a comprehensive understanding of how Discovery Learning integrated with local potential contributes to the development of Computational Thinking. Therefore, this study aims to synthesize existing research findings, identify emerging patterns, and highlight research gaps to inform future studies and instructional design in science education.

2. METHOD

This study employed a Systematic Literature Review (SLR) approach to synthesize research findings on the integration of Discovery Learning, local potential, and Computational Thinking (CT) in science education. The review followed Kitchenham's framework, which emphasizes a systematic, transparent, and replicable process consisting of planning, conducting, and reporting stages (Alifah et al., 2023; Nurfadilah et al., 2022).

2.1 Research Questions

The review was guided by the following research questions:

- RQ1: How is Discovery Learning implemented to support students' Computational Thinking skills?
- RQ2: How does the integration of local potential contribute to the development of Computational Thinking?
- RQ3: What research gaps exist in studies combining Discovery Learning, local potential, and Computational Thinking?

2.2 Search Strategy

The literature search was conducted using academic databases, including Google Scholar, Garuda (SINTA), and DOAJ. The Publish or Perish (PoP) tool was utilized to assist in retrieving articles from Google Scholar. The search keywords included "Discovery Learning," "Local Potential," and "Computational Thinking." The search was limited to publications from 2018 to 2025. In the identification stage, a total of 200 articles were retrieved based on the predefined keywords.

2.3 Study Selection Process

The selection process followed a flow consisting of identification, screening, eligibility, and inclusion stages, as illustrated in Figure 1.

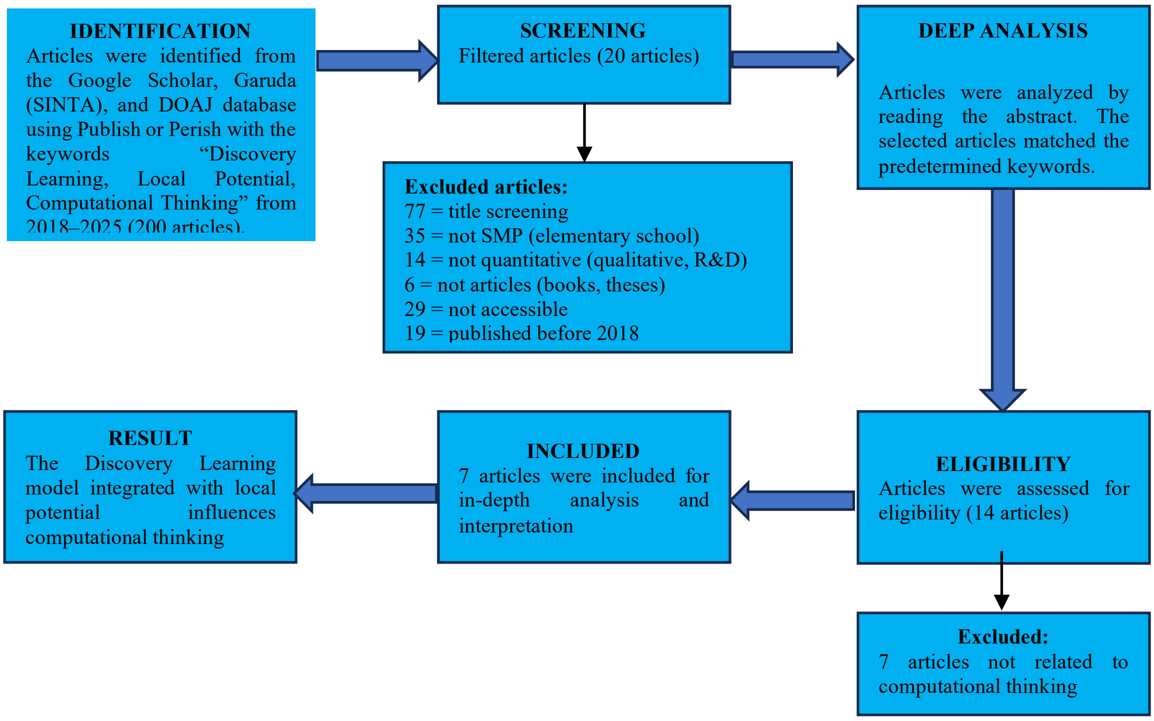

Figure 1. Flow diagram of the article exclusion and inclusion process in the stages of the Systematic Literature Review (SLR): Modified from Alifah et al (2023)

2.4 Inclusion and Exclusion Criteria

The inclusion criteria were:

1. Peer-reviewed journal articles or conference proceedings.
2. Studies addressing Discovery Learning, local potential (or local wisdom), and/or Computational Thinking.
3. Research conducted in educational contexts, particularly science learning.
4. Publications between 2018 and 2025.

The exclusion criteria included:

1. Studies not related to Computational Thinking.
2. Articles outside the scope of science education.
3. Non-research publications.
4. Articles without accessible full text.

2.5 Quality Assessment and Data Analysis

A quality assessment was conducted to ensure the rigor and relevance of the selected studies. The assessment focused on research design, methodological clarity, data analysis procedures, and alignment with the research variables. Data were analyzed using a descriptive-analytical approach. Each article was examined in terms of research objectives, methodology, sample characteristics, and key findings. The synthesis process emphasized identifying patterns, similarities, and differences across studies, particularly regarding the role of Discovery Learning and local potential in fostering Computational Thinking. This systematic procedure ensures transparency, reproducibility, and the reliability of the review findings.

3. RESULT AND DISCUSSION

The findings from the studies included in this literature review consist of an analysis and summary of articles related to Discovery Learning integrated with local potential in relation to critical thinking.

Table 1. Summary of the identified articles

No	Researcher	Journal	Result
1	(Hapsari et al., 2025)	Journal of Honai Math	The results of the study indicate that the Discovery Learning model has a significant effect on computational thinking skills, with MANOVA analysis showing an F-observed value of 13.770 at a 5% significance level. Quantitatively, the increase in mean scores also supports the statistical findings: in computational skills, the Discovery Learning group achieved a mean of 64.65, whereas the direct instruction group only reached 51.32. These results are consistent with the articles included in this study, indicating that both theoretically and empirically, there is a very strong relationship. The Discovery Learning model in this study has been quantitatively proven to provide a significant improvement in computational skills.
2	(Annisa et al., 2024)	Buletin Ilmiah Pendidikan	The results of the study indicate that the implementation of Discovery Learning based on local wisdom significantly improves students' learning outcomes. This is evidenced by essay test results administered to 42 students (21 in the experimental group and 21 in the control group), where the experimental class achieved a higher posttest mean score of 85.95 compared to 73.33 in the control class. Furthermore, the t-test significance value of

			0.001 (< 0.05) confirms a statistically significant effect of the model on students' cognitive abilities.
3	(Marina & Hartono, 2025)	Prosiding: Seminar Nasional Pendidikan Matematika (SNPM)	The results of the study indicate that students' numeracy skills improved after using computational thinking-based worksheets (LKPD) with a local wisdom context. Data were obtained through pretest and posttest administered to 26 students across four numeracy indicators. The findings show a shift in ability levels, from 24 students in the low category during the pretest to 14 students in the low category, 10 in the medium category, and 2 in the high category during the posttest. This improvement is further supported by an N-Gain score of 0.382, which falls into the moderate category, as well as increased scores across all indicators. For instance, the indicator of presenting data in diagrams increased from 15.14 to 64.42, while the indicator of analyzing diagram information increased from 54.81 to 88.46.
4	(Anjarwati et al., 2025)	Journal of Didactic Mathematics	The results of the study indicate that the implementation of Discovery Learning improves students' computational thinking skills, as evidenced by the higher mean score of the experimental class (67.60) compared to the control class (62.82). However, the Mann–Whitney test results show a p-value of 0.151 (> 0.05), indicating that the difference is not statistically significant. Further analysis reveals that computational thinking skills are strongly influenced by the level of self-regulated learning (SRL), as demonstrated by the Kruskal–Wallis test with a p-value of 0.000. Students with high SRL achieved an average score of 79.0, which is considerably higher than those with medium SRL (61.7) and low SRL (30.9).
5	(As'adah & Setiawan, 2024)	PENSA E-Jurnal: Pendidikan Sains	The results of the study indicate that the implementation of the Discovery Learning model is able to improve students' critical thinking skills, as evidenced by an N-Gain score of 0.64 (64.26%) in the experimental class, which falls into the moderate category, while the control class only reached 36.79%. The research data were collected through pretest–posttest assessments in two classes at SMPN 2 Gresik and were supported by observations of learning implementation, which reached 97.3% and were categorized as very good. These findings demonstrate that Discovery Learning

			is effective in promoting higher-order reasoning activities.
6	(Sa'adah et al., 2023)	Jurnal Math Educator Nusantara	The results of the study indicate that there is a significant change in students' computational thinking skills after the implementation of the Discovery Learning model using a STEAM approach. All data met the required statistical assumptions, as evidenced by the normality test results in the experimental class (Asymp. Sig = 0.084) and the control class (Asymp. Sig = 0.200), both of which are greater than 0.05, as well as the homogeneity test result (Sig = 0.687), indicating that the variances of the two groups are homogeneous. Further analysis using an independent t-test yielded a Sig. (2-tailed) value of 0.046, which is lower than the 5% significance level (0.05). This indicates a statistically significant t-value and leads to the conclusion that there is a significant difference in computational thinking skills between students taught using Discovery Learning–STEAM and those receiving conventional instruction.
7	(Azizah & Setyawarno, 2025)	Journal of Science Education Research	The results of the study indicate a significant improvement in students' computational thinking skills after the implementation of the Discovery Learning model integrated with STEM. Descriptively, the mean score of the experimental class increased from 49.37 to 73.75, while the control class improved from 57.19 to 66.87, with homogeneous data distribution as indicated by Sig. values of 0.319 (pretest) and 0.078 (posttest), both greater than 0.05. The effectiveness of the model was confirmed through a t-test, where the analysis yielded a Sig. (2-tailed) value of 0.013 in the posttest, which is lower than the 5% significance level. This indicates a significant t-value and a meaningful difference in computational thinking skills between the two classes. The effect of the model is further supported by an effect size of 0.544, which falls into the moderate category.

The synthesis of seven selected studies reveals a consistent pattern indicating that Discovery Learning, both as a standalone model and when integrated with contextual approaches such as local wisdom, STEAM, and STEM, contributes to the development of students' computational thinking and cognitive abilities. This consistency suggests that Discovery Learning provides a structured learning environment that facilitates higher-order thinking processes across different educational contexts.

Empirical evidence from (Hapsari et al., 2025) demonstrates a strong effect of Discovery Learning on computational thinking, as indicated by the MANOVA results (F =

13.770, $p < 0.05$), accompanied by a higher mean score in the experimental group (64.65) compared to the control group (51.32). Similar findings are reported by (Sa'adah et al., 2023) and (Azizah & Setyawarno, 2025), where Discovery Learning integrated with STEAM/STEM approaches significantly improves computational thinking, as evidenced by t-test results with significance values of 0.046 and 0.013, respectively. These findings collectively indicate that Discovery Learning consistently enhances computational thinking across various instructional designs.

The integration of local potential further strengthens these outcomes by providing meaningful and contextual learning experiences. The study by (Annisa et al., 2024) shows that Discovery Learning based on local wisdom significantly improves learning outcomes, with higher posttest scores in the experimental group (85.95) compared to the control group (73.33) and a significance value of 0.001. This finding highlights that contextualization through local potential not only improves conceptual understanding but also supports higher-order thinking skills. In line with this, (Marina & Hartono, 2025) report that computational thinking-oriented worksheets integrated with local context improve numeracy skills, as indicated by an N-Gain of 0.382 and a shift in students' performance levels from low to moderate and high categories. These results suggest a strong relationship between contextual learning and the development of analytical reasoning.

Further analysis reveals that the effectiveness of Discovery Learning is influenced by internal learner factors, particularly self-regulated learning (SRL). The findings of (As'adah & Setiawan, 2024) indicate that students with higher SRL achieve significantly better computational thinking performance (mean = 79.0) compared to those with moderate (61.7) and low (30.9) SRL levels. In addition, the same study reports that Discovery Learning improves critical thinking skills, with an N-Gain of 0.64 and high implementation fidelity (97.3%). These findings emphasize that the success of Discovery Learning is not only determined by instructional design but also by students' learning autonomy and engagement.

Across the reviewed studies, several common patterns emerge. First, Discovery Learning consistently supports the development of core computational thinking components, including decomposition, pattern recognition, abstraction, and algorithmic thinking. Second, the integration of contextual elements such as local potential enhances the relevance and meaningfulness of learning, thereby strengthening students' engagement and conceptual understanding. Third, the combination of Discovery Learning with interdisciplinary approaches (STEAM and STEM) further amplifies its impact on computational thinking.

Despite these consistent findings, several research gaps are identified. Most studies tend to examine Discovery Learning, local potential, and computational thinking separately rather than as an integrated framework. In addition, only a limited number of studies explicitly measure computational thinking indicators, and there is still a lack of structured instructional designs that systematically integrate local potential within Discovery Learning to develop CT skills.

The findings of this review reinforce the theoretical and empirical basis that contextualized Discovery Learning plays a significant role in fostering computational thinking. The integration of local potential serves not only as a contextual support but also as a conceptual tool that enables students to recognize patterns, analyze relationships between phenomena, and decompose problems related to heat and temperature in real-life contexts (Maharani et al., 2024). These processes directly correspond to the core components of computational thinking, namely decomposition, pattern recognition, abstraction, and algorithmic reasoning.

the literature demonstrates a clear and consistent trend that Discovery Learning, particularly when integrated with contextual and multidisciplinary approaches, enhances students' computational thinking and cognitive abilities. This indicates that such an approach is both pedagogically relevant and strategically important for science learning, especially in the context of heat and temperature.

4. CONCLUSION

This systematic literature review demonstrates that Discovery Learning consistently supports the development of students' Computational Thinking (CT) and cognitive abilities across various learning contexts. The findings indicate that the effectiveness of Discovery Learning becomes more pronounced when it is combined with contextual and interdisciplinary approaches, particularly through the integration of local potential, STEAM, and STEM. Such integration provides meaningful learning experiences that facilitate the development of core CT components, including decomposition, pattern recognition, abstraction, and algorithmic thinking. The review further highlights the important role of contextualization through local potential in enhancing the relevance of science learning, especially in heat and temperature topics. Context-based learning enables students to connect abstract scientific concepts with real-life phenomena, thereby strengthening both conceptual understanding and computational thinking processes. In addition, internal factors such as self-regulated learning contribute significantly to optimizing the effectiveness of Discovery Learning in fostering higher-order thinking skills. Despite these positive trends, this review identifies several research gaps, including the limited number of studies that explicitly integrate Discovery Learning, local potential, and Computational Thinking within a unified framework, as well as the lack of structured instructional designs and assessment tools targeting CT indicators. The findings of this study have important practical implications for science education. Teachers are encouraged to design Discovery Learning activities that incorporate local potential as a contextual resource to support the development of Computational Thinking. Future research should focus on developing comprehensive learning models and conducting empirical studies that explicitly measure CT components within contextualized science learning environments..

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