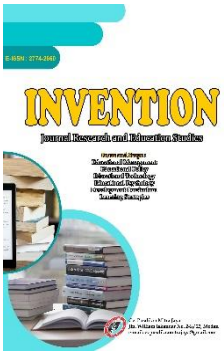

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A Synthesis of Research on the Implementation and Impact of the 5E Learning Cycle Model in Science Education

Odor Debora Pita Uli Sinaga[1], Helen Veronita H[2], Mariati Purnama Simanjuntak[3]
[1,2,3] *Universitas Negeri Medan, Indonesia*

ABSTRACT

The 5E Learning Cycle model has emerged as one of the most effective constructivist approaches for enhancing students' engagement and conceptual understanding in science learning. This study aims to comprehensively review the application and impact of the 5E Learning Cycle model on various aspects of learning in primary and secondary education. A systematic analysis was conducted on twenty peer-reviewed articles published between 2017 and 2025 to identify how this model influences cognitive, affective, and psychomotor learning outcomes. The review focuses on the effects of the 5E model on students' science process skills, science literacy, higher-order thinking skills, problem-solving abilities, and character development. Findings reveal that the implementation of the 5E Learning Cycle, which consists of the stages of Engagement, Exploration, Explanation, Elaboration, and Evaluation, successfully creates active, constructive, and meaningful learning experiences. The model's consistent application improves learning motivation, scientific attitudes, and conceptual mastery, with reported N-Gain values ranging from 0.37 to 0.69, indicating moderate to high improvement levels. Integrating the 5E model with learning strategies such as mind mapping, STEM-based worksheets, Quizwhizzer, and educational media further enhances its effectiveness in promoting science literacy and critical thinking. Although most studies emphasize short-term outcomes, overall findings confirm that the 5E Learning Cycle is a relevant and adaptive approach for addressing 21st-century learning challenges by fostering active engagement, deep understanding, and holistic character formation.

Kata Kunci *5E Learning Cycle, Learning Outcomes, Science Literacy*

Corresponding Author: odordeborapitaulisinaga@gmail.com

INTRODUCTION

The paradigm shift in 21st-century education requires innovative learning models that not only promote mastery of content but also foster critical, creative, communicative, and collaborative thinking. In this era, learning must emphasize the development of higher-order thinking skills, science literacy, and

character formation capable of responding to complex global challenges. Nevertheless, many learning practices in schools remain teacher-centered, emphasizing rote memorization rather than active participation and inquiry-based understanding. Such traditional methods tend to limit students' engagement, scientific process skills, and their ability to reason and apply knowledge in authentic contexts. This gap underscores the need for constructivist-based learning innovations that position students as active constructors of knowledge.

One of the most recognized models that respond to these educational challenges is the 5E Learning Cycle model, rooted in constructivist learning theory. The model—comprising five phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation—encourages learners to build understanding through exploration, reflection, and conceptual reconstruction. Previous studies (e.g., Bybee et al., 2006; Balci et al., 2020; Kurniawati & Suryani, 2022) have demonstrated the model's potential to enhance students' conceptual comprehension, critical thinking, and science process skills. Moreover, the 5E Learning Cycle has been effectively integrated with modern instructional approaches, such as STEM-based learning, mind mapping, 3D-thinking worksheets, and digital learning media (including Quizwhizzer, educational games, and interactive videos), which strengthen its constructivist and student-centered nature.

However, most existing studies have been limited to short-term analyses focused mainly on cognitive learning outcomes, without fully exploring the model's long-term effects on affective and motivational aspects, creativity, and the development of 21st-century competencies. This limitation represents a significant research gap that necessitates a comprehensive synthesis of current empirical evidence.

Therefore, the present study aims to conduct an in-depth literature review of twenty peer-reviewed articles published between 2017 and 2025, analyzing the trends, applications, and impacts of the 5E Learning Cycle model in primary and secondary education. This review seeks to identify patterns of implementation, measure its effectiveness in improving learning outcomes and scientific skills, and explore its potential for future educational innovations. By offering an integrated synthesis, this research contributes to the existing scholarship by clarifying the model's relevance, adaptability, and novelty as a constructivist approach that supports active, reflective, and competency-oriented learning in the 21st century.

RESEARCH METHOD

This study employed a systematic literature review (SLR) approach to identify, analyze, and synthesize empirical research findings related to the application of the 5E Learning Cycle model across various educational levels. The review covered twenty peer-reviewed journal articles published between 2017 and 2025, sourced from reputable national (SINTA-indexed) and international journals. The systematic process followed the principles outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring transparency, replicability, and comprehensiveness throughout the research procedure. Articles were collected through database searches in Google Scholar, Scopus, DOAJ, and the SINTA portal, using keywords such as Learning Cycle 5E, 5E learning model, learning outcomes, science literacy, HOTS, and science process skills. The inclusion criteria were as follows: (a) the study explicitly discussed the application of the 5E Learning Cycle model, (b) used experimental, descriptive, qualitative, or classroom action research designs, (c) reported measurable learning outcomes, (d) was published between 2017 and 2025, and (e) was available in full text. Non–peer-reviewed publications such as conference proceedings, books, and purely conceptual papers were excluded to maintain validity and reliability.

The review process was conducted through four main stages: identification, selection, eligibility screening, and synthesis. Each article was examined to extract key information, including the research purpose, methodology, sample, learning variables, instructional media used, and findings. Data were analyzed through descriptive and thematic synthesis, combining both quantitative and qualitative insights. Quantitative results—such as N-Gain scores, t-tests, and Mann-Whitney analyses—were used to evaluate the magnitude of improvement, while qualitative findings were examined narratively to identify emerging patterns and relationships across studies. To enhance the reliability of the synthesis, findings were grouped into three analytical domains: (1) cognitive (learning outcomes, conceptual understanding, and critical thinking), (2) affective (motivation, scientific attitudes, and engagement), and (3) psychomotor (science process and problem-solving skills).

The review also examined variations in implementation, such as the integration of the 5E model with innovative learning approaches including STEM-based learning, three-dimensional thinking worksheets, mind mapping, Quizwhizzer, educational games, and interactive videos. This analysis aimed to determine how these combinations enhance the model's effectiveness in promoting active and meaningful learning. Overall, this systematic literature

review provides a comprehensive overview of the trends, effectiveness, and directions for future development of the 5E Learning Cycle model in supporting active, reflective, and 21st-century skill-oriented education in Indonesia.

RESULT AND DISCUSSION

Based on the synthesis of twenty peer-reviewed articles published between 2017 and 2025, the 5E Learning Cycle model has consistently shown a significant positive effect on students' cognitive learning outcomes across multiple educational levels and subject domains. Studies in science, biology, physics, and economics report N-Gain values ranging from 0.37 to 0.69, indicating moderate to high improvement in conceptual understanding and academic achievement (Dianningrum & Sufian, 2025; Maulidah Salma & Aprilya Hariani, 2022). This enhancement aligns with the constructivist nature of the 5E framework—Engage, Explore, Explain, Elaborate, and Evaluate—which fosters learning through active inquiry, reflection, and contextual application. Students who learn under this model demonstrate not only better test performance but also stronger analytical reasoning and conceptual retention. These outcomes support previous theoretical perspectives from Piaget and Vygotsky, emphasizing that meaningful knowledge emerges through iterative experience and reflection.

The cognitive improvement achieved under the 5E framework reflects its capacity to move students from surface-level memorization to deep conceptual understanding. The Engage and Explore phases stimulate curiosity and activate prior knowledge, while Explain and Elaborate phases guide learners toward constructing and applying new concepts. The Evaluate phase reinforces metacognitive reflection, helping students internalize learning outcomes. Integration with innovative strategies—such as STEM, mind mapping, digital worksheets, Quizwhizzer, and educational videos—has been shown to enhance higher-order thinking and long-term retention by providing multimodal experiences that strengthen reasoning and transfer of knowledge (Frasiska et al., n.d.; Sari & Rahmi, 2024; Wahyuningsih et al., 2023).

Several quasi-experimental studies also reveal that the 5E Learning Cycle substantially improves students' science process skills (SPS) and scientific reasoning (Nida et al., 2017; Rosanti et al., 2023; Ristia et al., 2023). The Explore and Elaborate phases engage students in authentic scientific practices such as observation, data collection, and evidence-based interpretation, thereby reinforcing procedural fluency and inquiry competence. Learners exposed to 5E-based activities develop a more evidence-driven reasoning style,

demonstrating improved ability to justify conclusions, identify causal relationships, and evaluate the validity of results. These findings confirm that the 5E model bridges declarative, procedural, and metacognitive domains, fostering comprehensive scientific literacy and reasoning competence (Aprilia et al., 2023; Hayat et al., 2025; Ramdani et al., 2021).

In the affective domain, the reviewed studies consistently report increased motivation, engagement, and cooperative behavior as a result of 5E-based instruction (Dewi et al., 2025; Intania et al., 2025; Nida et al., 2017). The Engage phase evokes emotional involvement through real-world contexts, while the Elaborate phase facilitates collaboration, empathy, and communication. Game-based and digital media applications of the 5E model—such as Snakes and Ladders or Quizwhizzer—were particularly effective in enhancing motivation and social interaction (Maulidah Salma & Aprilya Hariani, 2024; Muliana et al., 2024). This confirms that the 5E model promotes holistic learning by integrating intellectual, emotional, and social dimensions, transforming classrooms into collaborative communities of inquiry.

Comparative analyses indicate that the model's impact varies according to context, subject matter, and technological integration. In elementary education, 5E produces the strongest improvements in motivation and practical skills due to its alignment with students' concrete operational stage. At secondary and tertiary levels, the model enhances abstract reasoning and conceptual understanding, particularly when combined with technological supports such as simulations, multi-representational tasks, and video-based instruction. These integrations make abstract content more accessible and reinforce the model's adaptability for 21st-century learning (Agustiana et al., 2025; Wulandari et al., 2024).

Table 1.
Synthesis of the Main Findings from 20 Articles on the Implementation of the 5E Learning Cycle Model

No	Researcher(s) & Year	Context / Level	Research Focus	Approach / Supporting Media	Main Findings	Implications
1	Rosanti et al. (2023)	Senior High – Physics	Mastery of Concepts & Science Process Skills	5E Learning Cycle + Link Map	Students with Link Map showed higher concept mastery and science skills	5E with visual mapping strengthens conceptual understanding
2	Ristia et al. (2023)	Junior High – Science	Scientific Reasoning	5E Learning Cycle + LKPD (3D Thinking Graph)	Moderate improvement (N-gain = 0.51) in scientific reasoning	3D graph-based LKPD effectively enhances analytical reasoning
3	Salong &	Senior High –	Learning	5E Learning Cycle	Improved	5E cycle

	Lasaiba (2024)	Economics	Outcomes	(Classroom Action Research)	mastery from 72.5% to 85%; increased engagement	promotes holistic learning and active participation
4	Sani et al. (2020)	Junior High – Science	Higher Order Thinking Skills (HOTS)	–	Significant improvement across cycles (62% → 87%)	5E proven effective for developing HOTS
5	Salma et al. (2022)	Senior High – Biology	Scientific Literacy & Learning Outcomes	5E Learning Cycle integrated with STEM	Significant improvement in literacy and achievement	STEM-based 5E strengthens scientific understanding and literacy
6	Budianti et al. (2023)	Elementary – Science	Science Learning Outcomes	Systematic Literature Review (2012–2022)	5E consistently improved students' learning results	5E suitable for building active, inquiry-based scientific learning
7	Dewi et al. (2025)	Elementary – Social Studies	Cooperative Character (Gotong Royong)	5E Learning Cycle + Snakes & Ladders Game	High improvement (89.8% vs 69.1%) in cooperation character	Game-based 5E fosters social values and collaborative learning
8	Sari et al. (2025)	Elementary – IPAS	Learning Outcomes	5E Learning Cycle + Video Media	Post-test significantly higher in experimental class (84.21 > 77.25)	Video-assisted 5E increases engagement and comprehension
9	Nida et al. (2017)	Junior High – Science	Science Process Skills	5E Learning Cycle + Mind Mapping	Effective in improving process and inquiry skills	Mind mapping in 5E enhances conceptual retention and activity
10	Wulandari et al. (2024)	Junior High – Science	Scientific Reasoning	5E Learning Cycle + LKPD (Multidimensional Thinking Diagram)	Significant positive effect on reasoning ability	Diagram-based 5E model develops logical and critical thinking
11	Hayat, N., Nastiti, L. R., & Yuliani, H. (2025)	Junior High School – Science	Critical Thinking Skills on Vibration Material	Learning Cycle 5E Model	Students' critical thinking improved from mean 34 to 59.43 with N-gain 0.372 (moderate)	The 5E model positively impacts critical thinking and can be applied to other materials for deeper cognitive understanding.
12	Muliana, A., Jufri, A. W., & Bahri, S. (2024)	Senior High School – Biology	Scientific Literacy	Learning Cycle 5E	5E model significantly improved students' scientific literacy ($p < 0.05$, 0.024)	5E model is effective for enhancing scientific literacy and fostering scientific reasoning among students.
13	Agustiana, N., Sumarni, W., Subali, B., & Widiarti, N. (2025)	All Levels – Science	Development of Learning Materials	Systematic Literature Review (PRISMA)	Majority of studies focus on product validation rather than	Future research should explore cognitive and noncognitive impacts of 5E-

					cognitive or affective outcomes.	based teaching materials.
14	Aprilia, F., Surahman, E., & Sujarwanto, E. (2023)	Senior High School – Physics	Critical Thinking Skills in Mechanical Waves	Practicum-based Learning Cycle 5E	Significant improvement in students' critical thinking (tcount 7.31 > ttable 2.65)	Practicum-based 5E model effectively develops critical thinking through active engagement and inquiry.
15	Nugraha, S., & Rahman, T. (2024)	Junior High School – Physics	Conceptual Understanding in Thermodynamics	Learning Cycle 5E Model	Improvement in conceptual understanding and motivation among students.	The 5E model supports meaningful learning and concept retention.
16	Rahmawati, D., & Yusuf, M. (2024)	Elementary – Science	Problem Solving in Environmental Education	5E with Contextual Approach	Students' problem-solving skills improved significantly post-intervention.	Integrating 5E with contextual learning fosters critical environmental awareness.
17	Sari, N., & Rahmi, L. (2024)	Elementary – Science	Learning Outcomes in Sound and Its Properties	Learning Cycle 5E	Positive effect on students' science learning outcomes (Paired t-test significant)	5E enhances active participation and understanding of scientific phenomena.
18	Pratiwi, A., & Fadillah, R. (2024)	Senior High School – Chemistry	Learning Motivation and Achievement	Learning Cycle 5E with Project-Based Learning	Increased motivation and achievement compared to conventional methods.	5E integrated with PjBL increases engagement and achievement simultaneously.
19	Wulandari, D., & Astuti, S. (2024)	University Level – Physics Education	Metacognitive Skills	Learning Cycle 5E with Reflective Journal	Improvement in metacognitive awareness and learning autonomy.	Reflective-based 5E model enhances self-regulated learning and reflection skills.
20	Dianningrum, M. C., & Sufian, E. K. M. (2025)	Senior High School – Physics (Kinematics)	Conceptual Understanding and Representational Fluency	Learning Cycle 5E with Multi-Representational Approach	Students' understanding (N-gain = 0.693) and fluency (N-gain = 0.654) improved significantly.	The 5E model with multiple representations effectively builds deep conceptual and representational understanding.

Despite the overall consistency of positive findings, methodological limitations must be acknowledged. Most reviewed studies adopted quasi-experimental or classroom action research designs with relatively small sample sizes, short intervention periods, and limited randomization. Consequently, the generalization of findings should be made cautiously (Agustiana et al., 2025; Rosanti et al., 2023; Wahyuningsih et al., 2023). Furthermore, several studies lacked detailed reporting on the reliability and validity of instruments, while

few employed mixed-method approaches that could enrich interpretation through qualitative data. Short-term interventions also restrict the ability to assess long-term concept retention or transfer. Future research should therefore employ stronger designs—such as cluster randomized trials, longitudinal tracking, and cross-disciplinary replications—to validate and extend the evidence base.

Overall, this review confirms that the 5E Learning Cycle model is a robust and flexible constructivist approach that effectively enhances students' cognitive, affective, and procedural learning outcomes. Its adaptability across subjects and educational levels, particularly when integrated with technology and inquiry-based methods, makes it a relevant pedagogical framework for cultivating 21st-century competencies. However, to solidify its position as an evidence-based model, more rigorous, large-scale, and longitudinal research remains essential.

CONCLUSION

Based on the synthesis of twenty reviewed research articles, it can be concluded that the 5E Learning Cycle model is an effective and adaptive instructional framework for improving students' cognitive, affective, and psychomotor learning outcomes across educational levels. Its constructivist stages—Engage, Explore, Explain, Elaborate, and Evaluate—encourage students to actively construct understanding, foster curiosity, and connect learning experiences to meaningful scientific concepts, aligning with the student-centered approach of the Merdeka Curriculum.

The consistent findings of moderate to high N-Gain values (0.37–0.69) indicate significant improvement in learning outcomes, particularly in scientific literacy, process skills, reasoning, problem solving, and higher order thinking skills (HOTS). Moreover, integrating the 5E model with digital tools and approaches such as STEM, mind mapping, Quizwhizzer, learning videos, and educational games further enhances engagement, motivation, and collaboration among students.

However, its effectiveness remains influenced by factors such as educational level, learning material, implementation duration, and teacher competence. Most studies still emphasize short-term cognitive gains, with limited exploration of long-term effects on motivation, creativity, and affective growth. Future research using longitudinal and mixed-method designs is recommended to provide a more comprehensive understanding of the 5E model's holistic impact on 21st-century skills.

Overall, this review confirms that the 5E Learning Cycle serves as a relevant and powerful pedagogical framework to support modern science education and the goals of the Merdeka Curriculum, promoting not only knowledge acquisition but also the development of critical thinking, scientific attitude, and social character essential for lifelong learning.

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REFERENCES

Agustiana, N., Sumarni, W., Subali, B., & Widiarti, N. (2025). *Kajian literatur sistematis pengembangan bahan ajar IPA berbasis Learning Cycle 5E.* Retrieved from https://jurnaldidaktika.org

Aprilia, F., Surahman, E., & Sujarwanto, E. (2023). *The effect of the practicum-based Learning Cycle 5E learning model on critical thinking skills on mechanical wave material. Berkala Ilmiah Pendidikan Fisika, 11*(2), 255. https://doi.org/10.20527/bipf.v11i2.16193

Desyana, N., & Mufti, N. (2024). *Analysis of students' problem-solving skills in Newton's law with 5E Learning Cycle. Jurnal Pendidikan Sains, 12*(4), 152–159. https://doi.org/10.17977/jps.v12i42024p152

Dewi, N. M. R. S., Wulandari, I. G. A. A., & Astawan, I. G. (2025). *The effect of the 5E Learning Cycle model with snakes and ladders game on students' cooperation. Indonesian Values and Character Education Journal, 8*(1), 197–209. https://doi.org/10.23887/ivcej.v8i1.91280

Dianningrum, M. C., & Sufian, E. K. M. (2025). *Improving students' understanding and representational fluency of kinematics through Learning Cycle 5E with multi-representational approach. Jurnal Pendidikan Sains, 13*(1), 20–25. https://doi.org/10.17977/jps.v13i12025p020

Frasiska, A., Purwati, S., & Palenewen, E. (n.d.). *Pengaruh model pembelajaran Learning Cycle 5E berbantuan Quizwhizzer terhadap hasil belajar kognitif siswa pada materi sistem ekskresi. Eduproxima: Jurnal Ilmiah Pendidikan IPA.* Retrieved from http://jurnal.stkippgritulungagung.ac.id/index.php/eduproximam

Hayat, N., Nastiti, L. R., & Yuliani, H. (2025). *Profil kemampuan berpikir kritis*

siswa materi getaran dengan model Learning Cycle 5E. Lambda: Jurnal Ilmiah Pendidikan MIPA dan Aplikasinya, 5(2), 468–476. https://doi.org/10.58218/lambda.v5i2.1449

Intania, K. R., Margunayasa, I. G., & Widiastuti, N. P. K. (2025). *The 5E Learning Cycle model assisted by mind mapping on the learning outcomes of IPAS for fifth-grade students. Mimbar Ilmu, 30*(1), 153–160. https://doi.org/10.23887/mi.v30i1.95727

Maulidah, I. S., & Hariani, S. A. (n.d.). *Pengaruh model pembelajaran Learning Cycle (5E) berbasis STEM terhadap literasi sains dan hasil belajar siswa kelas X. DWIJA CENDEKIA: Jurnal Riset Pedagogik.*

Muliana, A., Jufri, A. W., & Bahri, S. (2024). *The effect of Learning Cycle 5E model on the scientific literacy of 10th grade students. Jurnal Penelitian Pendidikan IPA, 10*(9), 6662–6668. https://doi.org/10.29303/jppipa.v10i9.8415

Nida, S., Mahanal, S., & Pradana, D. (2017). *Keefektifan model Learning Cycle 5E dipadu teknik mind mapping untuk meningkatkan keterampilan proses sains siswa SMP. PSEJ, 2*(1), 1–10. Retrieved from http://e-journal.ups.ac.id/index.php/psej

Putri Ristia, H., Nuha, U., & Supeno, S. (2023). *Model Learning Cycle 5E berbantuan LKPD berbasis three-dimensional thinking graph dan pengaruhnya terhadap scientific reasoning pada siswa SMP. Jurnal Paedagogy, 10*(3), 703. https://doi.org/10.33394/jp.v10i3.7283

Ramdani, A., Jufri, A. W., Gunawan, Fahrurrozi, M., & Yustiqvar, M. (2021). *Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5E Learning Cycle integrated with local wisdom. Jurnal Pendidikan IPA Indonesia, 10*(2), 187–199. https://doi.org/10.15294/jpii.v10i2.29956

Rosanti, D. F., Diantoro, M., Kusairi, S., & Yulianti, E. (2023). *The influence of the 5E Learning Cycle strategy with a link map on students' mastery of physics concepts and science process skills. Jurnal Pendidikan Sains, 11*(1), 27–34. https://doi.org/10.17977/jps.v11i12023p027

Salong, A., & Lasaiba, M. A. (2024). *Efektivitas model Learning Cycle 5E dalam meningkatkan hasil belajar siswa. SAP (Susunan Artikel Pendidikan), 9*(1).

Sani, M. M. R., Meha, A. M., & Nenotek, S. A. (2020). *Penerapan model siklus belajar 5E untuk meningkatkan kemampuan berpikir tingkat tinggi (HOTS) siswa di SMP Adhyaksa 2 Kupang tahun ajaran 2018/2019. Jurnal Sains dan Edukasi Sains, 3*(1), 15–23. https://doi.org/10.24246/juses.v3i1p15-23

Sari, N., & Rahmi, L. (2024). *Pengaruh model Learning Cycle 5E terhadap hasil belajar IPA pada materi bunyi dan sifatnya di kelas V sekolah dasar. Cetta: Jurnal Ilmu Pendidikan, 7*(4).

https://jayapanguspress.penerbit.org/index.php/cetta

Wahyuningsih, R., Budianti, Y., & Aarrahim, A. (2023). *Penerapan model pembelajaran Learning Cycle 5E terhadap hasil belajar IPA siswa sekolah dasar. Jurnal Elementaria Edukasia, 6*(2), 844–857. https://doi.org/10.31949/jee.v6i2.5087

Wulandari, T., Supeno, S., & Wahyuni, D. (2024). *Pengaruh model Learning Cycle 5E disertai LKPD berbasis diagram berpikir multidimensi terhadap kemampuan scientific reasoning siswa SMP. Jurnal Sains dan Edukasi Sains, 7*(1), 1–11. https://doi.org/10.24246/juses.v7i1p1-11