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TEACHING GRAVITY CONCEPTS IN PRIMARY SCIENCE EDUCATION: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Gravity is a fundamental topic in primary science education, yet its abstract nature often leads to misconceptions and learning difficulties among young learners. This study aimed to synthesize recent research on instructional approaches for teaching gravity concepts in primary schools and to identify emerging trends and implications for science education. A systematic literature review was conducted following the PRISMA 2020 guidelines. An initial set of 200 articles was retrieved from Google Scholar using Publish or Perish (PoP). After removing duplicates and applying predefined inclusion and exclusion criteria, nine studies published between 2021 and 2026 were selected for analysis. The findings revealed four major themes: student-centered pedagogical approaches, digital and interactive learning media, experiential learning activities, and Einsteinian perspectives on gravity education. Approaches such as demonstrations, Project-Based Learning, and Problem-Based Learning were associated with improved student engagement and conceptual understanding. Digital tools, including YouTube, Liveworksheet, and Augmented Reality, enhanced visualization and motivation, while hands-on experiments supported experiential learning. Moreover, several studies demonstrated that simplified Einsteinian concepts could be meaningfully introduced at the primary level. These findings suggest that integrating active learning strategies, multiple representations, and modern scientific perspectives can enrich gravity instruction and foster deeper scientific understanding among primary students.

Keywords: Gravity Education, Primary Science Education, Conceptual Understanding, Digital Learning Media, Einsteinian Physics, Systematic Literature Review.

INTRODUCTION

Science education is a fundamental component of the primary school curriculum, providing young learners with essential scientific knowledge and fostering an understanding of natural phenomena encountered in everyday life. Beyond introducing scientific concepts, primary science education aims to cultivate critical thinking, inquiry skills, and scientific literacy by encouraging students to observe, question, investigate, and interpret the world around them. The learning process is typically facilitated through a combination of instructional activities, theoretical explanations, and appropriate learning media designed to promote scientific reasoning and conceptual understanding (Saputra et al., 2024). As children progress through primary education, they become increasingly aware of their surroundings and develop a greater capacity to recognize and interpret natural events and real-world challenges. Primary school students are naturally characterized by a strong sense of curiosity, particularly toward unfamiliar phenomena and the environment in which they live (Selvi, 2025). Through engaging and enjoyable learning experiences, science education enables students to broaden their perspectives and develop scientific knowledge that can be applied both inside and outside the classroom (Karno et al., 2024).

Gravity is one of the fundamental concepts introduced in primary science education because it explains many natural phenomena that children encounter in their daily lives. Through learning about gravity, students begin to understand why humans remain on the Earth's surface, why objects fall toward the ground, and how celestial bodies move within the solar system. These concepts provide the foundation for understanding force, motion, and other scientific principles that students will explore in later stages of science education. Consequently, gravity serves as a bridge between everyday observations and scientific explanations, allowing students to construct a more meaningful understanding of the physical world. Moreover, learning about gravity introduces children to broader topics in astronomy and space science, enabling them to connect familiar experiences with phenomena occurring beyond Earth. Such integration supports scientific literacy and encourages students to explore the universe through evidence-based reasoning (Febriana & Permata, 2026).

Space-related phenomena, including planets, the Moon, stars, and space exploration, naturally attract the interest of primary school students. At the elementary level, children are highly curious about the universe and frequently ask questions about objects and events beyond the Earth. This curiosity provides valuable opportunities for teachers to create meaningful and engaging science learning experiences. By integrating gravity concepts with astronomy and space-related topics, educators can present scientific ideas in ways that are both relevant and enjoyable for young learners. Such approaches not only increase students' motivation but also encourage active participation and support the development of conceptual understanding (Murtadlo & Prasetyo, 2024).

Despite its importance and appeal, gravity remains one of the most challenging concepts for primary school students to understand. Unlike many observable natural phenomena, gravitational force cannot be directly seen; students can only recognize its effects through everyday experiences and natural events. Consequently, many learners struggle to construct accurate scientific explanations and often develop misconceptions about gravity. These difficulties are largely attributed to the abstract nature of the concept and the cognitive demands required to understand invisible forces at an early age (Akram et al., 2022). Therefore, effective instruction requires teachers to employ creative pedagogical approaches and appropriate instructional media that transform abstract concepts into meaningful learning experiences. Visualizations, hands-on activities, and interactive learning resources have the potential to improve conceptual understanding and promote meaningful science learning (Murtadlo & Prasetyo, 2024).

Research on science learning challenges indicates that abstract scientific concepts represent one of the greatest difficulties for primary school students. Diverse instructional approaches can provide meaningful learning experiences that support children's understanding of space-related concepts, particularly gravity (Syahputra et al., 2022). Nevertheless, these challenges frequently develop into persistent misconceptions that are commonly observed across different educational contexts.

Previous studies have consistently reported that misconceptions about force and gravity remain prevalent among primary school students. One of the most common misconceptions is the belief that force is always required to keep an object in motion, reflecting students' limited understanding of fundamental physical principles. Mariyadi & WA (2023) reported that 66.7% of primary school students demonstrated misconceptions related to gravitational force and emphasized the need for more appropriate instructional models and learning media to address these conceptual difficulties. Similarly, Amelia & Ramadhani (2025) found that many students experienced difficulties in understanding non-contact forces such as gravity and magnetism. Their findings suggested that experiment-based learning activities provide meaningful experiences that help students reconstruct their scientific understanding. Collectively, these studies indicate that well-designed instructional media and active learning strategies play an essential role in reducing misconceptions and improving students' conceptual understanding of gravity (Amelia & Ramadhani, 2025).

Various approaches have been proposed to identify and address students' misconceptions regarding gravity and force concepts. One of the most commonly used methods is the Three-Tier Diagnostic Test, which has proven effective in identifying misconceptions among primary school students. Findings from these studies indicate that misconceptions remain widespread, highlighting the need for contextual learning experiences and diverse experiment-based activities that encourage students to reconstruct their scientific understanding (Kusumaningtyas et al., 2025). Although previous investigations have provided valuable insights into gravity instruction, most studies focus on specific interventions, learning media, or local educational contexts. Consequently, evidence regarding dominant instructional trends, emerging innovations, and effective teaching practices remains fragmented and lacks comprehensive synthesis (Alaniz-Álvarez et al., 2024).

Therefore, a comprehensive review is needed to integrate the findings of previous studies through a systematic and transparent approach. A Systematic Literature Review (SLR) provides a rigorous method for identifying, evaluating, and synthesizing existing evidence, enabling researchers to develop a comprehensive understanding of a particular topic (Asani, 2023). In science education, SLR has been widely employed to examine instructional strategies, learning media, and educational innovations while identifying evidence-based practices and emerging research trends (Baskoro et al., 2025). Applying this approach to gravity education can provide valuable insights into current pedagogical developments and support the design of more effective instructional practices for primary school students (Baqy et al., 2025).

Accordingly, this study conducts a Systematic Literature Review on teaching gravity concepts in primary science education. Specifically, this review addresses the following research questions: (1) What pedagogical approaches have been employed to teach gravity concepts in primary science education? (2) How do digital media and experiential learning activities support students' understanding of gravity concepts? (3) What evidence exists regarding the introduction of Einsteinian perspectives in primary science classrooms? The findings of this review are expected to provide useful guidance for teachers, researchers, and curriculum developers in designing more effective, engaging, and evidence-based science learning experiences for young learners.

METHODOLOGY

This study adopted a Systematic Literature Review (SLR) methodology to systematically identify, evaluate, and synthesize empirical evidence on the teaching of gravity concepts in primary science education. The review was conducted in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which offer a comprehensive framework for ensuring transparency and methodological rigor throughout the review process (Page et al., 2021). Following these guidelines, the review consisted of four sequential stages: identification, screening, eligibility assessment, and inclusion.

The literature search was carried out in July 2026 using Publish or Perish (PoP) as the search platform, with Google Scholar serving as the primary source of publications. Google Scholar was selected because of its broad coverage of educational research, encompassing both international and local journals relevant to primary science education. To retrieve studies aligned with the research objectives, a search strategy was developed by combining keywords related to gravity concepts, science education, and primary education using Boolean operators.

The search string used in this study was as follows:

("gravity" or "gravity concept" or gravitation) and (teaching or learning or instruction or "science education") and ("primary school" or "elementary school" or "primary education")

The search was restricted to full-text journal articles published between 2021 and 2026 in either English or Indonesian. A maximum of 200 records was obtained through Publish or Perish. After retrieval, all records were exported and processed according to the PRISMA 2020 protocol. The predefined inclusion and exclusion criteria applied during the selection process are presented in Table 1.

Table 1. *Inclusion and Exclusion Criteria*

Aspect	Inclusion Criteria	Exclusion Criteria
Publication Year	Research articles published from 2021 to 2026.	Publications released before 2021.
Educational Level	Studies conducted with Primary or Elementary School students.	Studies involving participants from preschool, secondary

		school, higher education, or other educational settings.
Research Topic	Studies addressing gravity concepts, gravitation, or gravity-related learning within science education.	Studies that do not focus on gravity concepts or are unrelated to science education.
Research Focus	Studies examining instructional strategies, teaching methods, learning models, educational media, conceptual understanding, misconceptions, or learning outcomes associated with teaching gravity concepts.	Studies emphasizing theoretical or applied physics without an educational perspective, or those unrelated to gravity instruction.
Publication Type	Full-text empirical research articles published in peer-reviewed journals	Review papers, conference proceedings, books, book chapters, theses, dissertations, editorials, or publications without accessible full text.
Language	Articles published in English or Indonesian	Publications written in languages other than English or Indonesian.

The article selection procedure followed the PRISMA 2020 workflow. Duplicate records were first identified and removed. The remaining studies were subsequently screened by reviewing their titles and abstracts to determine their relevance to the topic of teaching gravity concepts in primary science education. Studies that passed the initial screening underwent a full-text evaluation to verify their compliance with the established eligibility criteria. Articles were excluded if they involved educational levels other than primary school, did not focus on gravity-related learning, represented review papers, conference proceedings, theses, dissertations, or lacked full-text availability. At the end of the selection process, nine studies satisfied all eligibility requirements and were included in the final review.

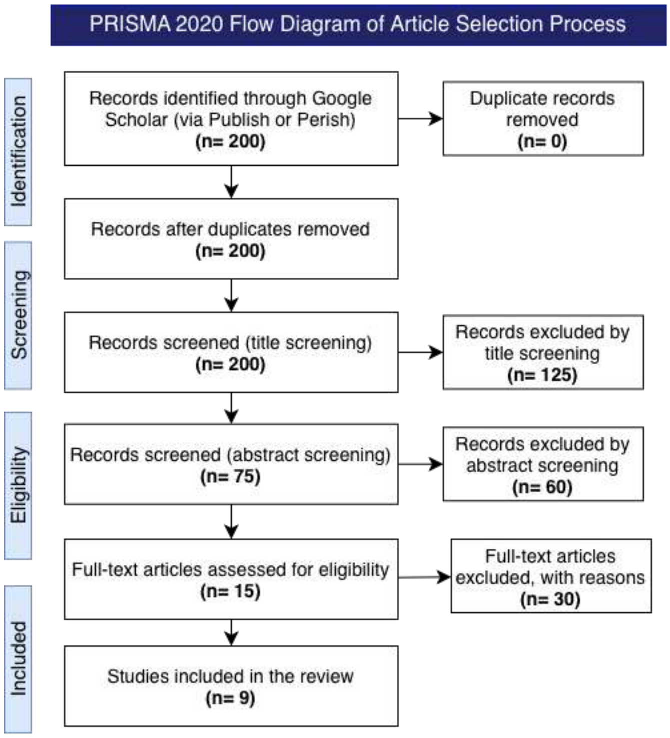

Figure 1. *The PRISMA 2020 flow diagram illustrating the article selection process.*

Data from the selected studies were extracted using a standardized extraction form to maintain consistency throughout the review process. The extracted information included the authors, year of publication, country, research objectives, research design, participant characteristics, instructional approaches, learning media, and principal findings related to gravity instruction in primary science education.

The synthesized data were analyzed using thematic analysis to identify recurring themes and patterns across the selected studies. Thematic analysis was employed because it enables researchers to identify, organize, and interpret recurring patterns across multiple studies, thereby facilitating a comprehensive synthesis of instructional practices in gravity education. The analytical process consisted of four stages: (1) carefully reviewing each article to gain a comprehensive understanding of its content; (2) identifying evidence related to instructional strategies, digital media, experiential learning activities, and students' conceptual understanding of gravity; (3) grouping similar findings into broader thematic categories; and (4) integrating these themes to formulate conclusions regarding effective instructional practices for teaching gravity concepts in primary science education.

RESULTS

Following the PRISMA screening process, nine studies published between 2021 and 2026 met the inclusion criteria and were included in this review. The studies originated from four countries, namely Indonesia, Italy, Australia, and Greece, and employed diverse research designs, including quasi-experimental studies, classroom action research, intervention studies, research and development, and service-learning programs.

Table 2. *Characteristics of Included Studies*

No.	Authors	Country	Participants	Research Design	Learning Approach/ Media	Main Findings
1.	(Ruggiero et al., 2021)	Italy	Primary School Students	Intervention Study	Einsteinian Gravity Approach	Students demonstrated an understanding of basic Einsteinian gravity concepts.
2.	(Adams et al., 2021)	Australia	Primary Students	Longitudinal Follow-Up	Einstein First Program	Modern gravity concepts and positive attitudes were retained after nine years.
3.	(Aisyah	Indonesia	40 Grade IV	Quasi-	YouTube	Significant

	et al., 2023)		Students	Experiment	Media	improvements in science achievement were observed (p = 0.019).
4.	(Putera et al., 2025)	Indonesia	Grade IV Students	Classroom action research	Demonstration method	Learning mastery increased from 25% to 100% across two cycles.
5.	(Manf'ati et al., 2025)	Indonesia	Grade IV Students	Classroom action research	PjBL with comic media	Student mastery improved from 42.8% to 89.3%.
6.	(Sartika et al., 2025)	Indonesia	30 Primary Students	Service-learning program	Gravity capsule experiment	Students achieved a comprehension rate of 78.5%.
7.	(Alfitria et al., 2025)	Indonesia	54 Grade IV Students	Quasi-experiment	Liveworksheet media	Interactive worksheets and motivation significantly affected learning outcomes.
8.	(Amani et al., 2025)	Indonesia	Elementary Students	Research and development	AR integrated with PBL	AR-based instruction effectively supported conceptual understanding.
9.	(Vakarou & Kotsis, 2026)	Greece	Sixth-Grade Students	Experimental study	Einsteinian model-based instruction	Significant conceptual gains occurred without gender

differences.

The nine studies included in this review were conducted across four countries, namely Indonesia, Italy, Australia, and Greece. Indonesian studies dominated the dataset, accounting for six of the nine selected articles, while the remaining studies represented European and Australian educational contexts. This distribution suggests that research on gravity instruction at the primary level has received growing attention in Southeast Asia, particularly in relation to instructional innovation and classroom-based interventions.

In terms of research design, classroom action research and quasi-experimental studies were the most frequently employed methodologies. Other approaches included intervention studies, longitudinal follow-up research, service-learning programs, research and development designs, and experimental studies. This methodological diversity indicates that gravity education has been explored from multiple perspectives, ranging from practical classroom implementation to long-term conceptual development.

Regarding instructional innovations, digital technologies and student-centered pedagogies emerged as dominant trends. Several studies integrated multimedia resources such as YouTube, Liveworksheet, and Augmented Reality to enhance visualization and student engagement. At the same time, active learning approaches, including demonstrations, Project-Based Learning, and Problem-Based Learning, emphasized students' direct involvement in constructing scientific understanding. These patterns reflect a broader shift from traditional teacher-centered instruction toward more interactive and experiential models of science education.

The thematic analysis ultimately identified four major themes: (1) student-centered pedagogical approaches, (2) digital and interactive learning media, (3) experiential learning activities, and (4) Einsteinian perspectives on gravity education. Together, these themes provide a comprehensive overview of contemporary practices and emerging directions in teaching gravity concepts within primary science classrooms.

Table 3. *Thematic Synthesis of Findings*

Theme	Representative Studies	Frequency	Key Contributions

Student-centered pedagogies	Putera et al.; Manf'ati et al.; Amani et al.	3	Promoted active participation and conceptual engagement.
Digital and interactive media	Aisyah et al.; Alfitria et al.; Amani et al.	3	Enhanced visualization, motivation, and learning outcomes.
Experiential learning	Putera et al.; Sartika et al.	2	Connected abstract concepts with observable experiences.
Einsteinian approaches	Ruggiero et al.; Adams et al.; Vakarou & Kotsis	3	Introduced modern perspectives on gravity and conceptual change.

The distribution of themes indicates that contemporary gravity instruction at the primary level increasingly incorporates active learning strategies and technological innovations. In addition, several international studies have explored the feasibility of introducing Einsteinian interpretations of gravity, suggesting an emerging trend toward integrating modern physics concepts into elementary science education.

DISCUSSION

1. Student-Centered Pedagogies in Teaching Gravity

The reviewed literature suggests that student-centered instructional approaches play an important role in supporting children's understanding of gravity concepts. Demonstration methods, Project-Based Learning (PjBL), and Problem-Based Learning (PBL) were frequently employed to encourage active participation and meaningful engagement with scientific phenomena. Rather than relying exclusively on teacher explanations, these approaches provided opportunities for learners to observe, investigate, and construct explanations through direct experiences.

Across the studies, a common pattern emerged: learning activities that required students to interact with problems, projects, or demonstrations were associated with improvements in conceptual understanding and learning achievement. For example, demonstration-based instruction enabled learners to directly observe gravitational phenomena, while project-based activities supported collaboration and contextualized scientific reasoning (Manf'ati et al., 2025; Putera et al., 2025).

These findings align closely with constructivist learning theory, which emphasizes that learners actively construct knowledge through interaction with their environment and social experiences. Within primary science education, concepts such as gravity cannot be effectively understood through memorization alone because students must connect abstract explanations with concrete observations. Activities involving demonstrations, collaborative projects, and problem-solving tasks therefore provide opportunities for learners to negotiate meaning and refine their existing conceptions. From this perspective, student-centered pedagogies not only improve academic achievement but also facilitate deeper conceptual change and scientific reasoning.

2. Digital Media as Tools for Conceptual Visualization

Digital technologies constituted another prominent theme across the reviewed studies. Although the interventions employed different platforms, including YouTube videos, Liveworksheet activities, and Augmented Reality applications, they shared a common objective: making invisible gravitational processes more accessible and understandable to young learners.

The findings indicate that multimedia representations can support both motivation and conceptual development. Audiovisual explanations delivered through YouTube enhanced students' science achievement by providing concrete illustrations of gravitational phenomena that are difficult to observe directly (Aisyah et al., 2023). Similarly, Liveworksheet activities promoted learner engagement through interactive exercises and immediate feedback mechanisms (Alfitria et al., 2025)

Augmented Reality offered an even more immersive experience by enabling students to visualize three-dimensional representations of gravitational interactions. Despite differences in technological complexity, all three approaches appear to reduce cognitive barriers associated with abstract scientific content and encourage active engagement with learning tasks (Aisyah et al., 2023; Alfitria et al., 2025; Amani et al., 2025).

These observations are consistent with Multimedia Learning Theory, which proposes that learners develop deeper understanding when verbal explanations are integrated with meaningful visual representations. For gravity education, where many processes cannot be observed directly, digital tools may therefore serve as important mediators of conceptual understanding.

Furthermore, the integration of digital technologies in primary science classrooms reflects broader educational shifts toward learner-centered and technology-enhanced instruction. Rather than functioning merely as supplementary resources, digital media can facilitate conceptual change by enabling students to explore scientific phenomena through multiple forms of representation. Interactive and immersive environments encourage learners to connect prior experiences with new knowledge, thereby strengthening both motivation and conceptual retention. Consequently, the effective integration of digital tools should be accompanied by pedagogical strategies that promote inquiry, discussion, and active participation to maximize learning outcomes in gravity education.

3. Experiential Learning and Hands-on Activities

Experiential learning emerged as another significant component of effective gravity instruction. Several studies emphasized the importance of connecting scientific explanations with concrete experiences through demonstrations, experiments, and simple physical activities.

The gravity capsule program exemplifies how accessible experimental tools can foster curiosity and scientific reasoning among elementary students. Through playful investigations involving motion, gravity, and momentum, learners engaged actively with scientific concepts and demonstrated substantial levels of comprehension (Sartika et al., 2025). Similarly, classroom demonstrations enabled students to observe causal relationships directly and test their predictions about gravitational behavior (Putera et al., 2025).

Across these interventions, experiential activities served as bridges between abstract scientific principles and everyday experiences. Rather than memorizing definitions, students were encouraged to construct explanations grounded in observation and evidence. Such findings reflect the principles of experiential learning theory, which emphasizes the cyclical relationship between concrete experience, reflection, conceptualization, and active experimentation.

Moreover, experiential approaches align closely with inquiry-based science education, which encourages students to formulate questions, test predictions, and construct explanations from empirical evidence. By actively participating in investigations, learners develop not only conceptual understanding but also essential scientific process skills, including observation, reasoning, and communication. Consequently, integrating hands-on experiences into gravity instruction may contribute to stronger scientific literacy and foster more positive attitudes toward science learning among primary school students.

The evidence therefore suggests that simple, low-cost experiments may represent effective alternatives for schools with limited laboratory facilities while simultaneously supporting meaningful science learning.

4. Einsteinian Perspectives and Conceptual Change

One of the most distinctive findings of this review concerns the increasing inclusion of Einsteinian perspectives within primary science education. Traditionally, gravity instruction at the elementary level has focused exclusively on Newtonian explanations; however, recent studies indicate that younger learners may be capable of understanding simplified representations of modern physics when appropriate instructional supports are provided.

Research conducted in Italy, Australia, and Greece consistently reported positive conceptual outcomes following Einsteinian interventions (Adams et al., 2021; Ruggiero et al., 2021; Vakarou & Kotsis, 2026). Physical analogies, guided inquiry activities, and spacetime simulations enabled students to develop alternative understandings of gravity beyond force-based interpretations. Moreover, the Greek study reported no significant gender differences in conceptual gains, suggesting that such approaches may contribute to more inclusive science learning environments.

These findings can be interpreted through the lens of conceptual change theory. Introducing Einsteinian explanations encourages learners to reconsider existing mental models and reconstruct their understanding using more comprehensive scientific frameworks. Nevertheless, caution should be exercised when generalizing these results, as the interventions were implemented in carefully designed educational settings with substantial instructional support.

Despite these limitations, the reviewed studies challenge traditional assumptions regarding developmental readiness for modern physics concepts and open possibilities for curriculum innovation in primary science education.

5. Implications for Teaching, Curriculum, and Future Research

The synthesis of findings offers several implications for educational practice. For classroom teachers, the evidence suggests that combining demonstrations, inquiry activities, and digital media may help students overcome misconceptions and develop stronger conceptual understanding of gravity. Multiple representations, including experiments, videos, simulations, and visual narratives, appear particularly valuable for addressing the abstract nature of gravitational phenomena.

For curriculum developers, the emergence of Einsteinian approaches highlights opportunities to gradually introduce contemporary scientific perspectives at earlier educational stages. Rather than replacing Newtonian explanations, modern concepts may complement existing content through age-appropriate analogies and inquiry-based activities.

Future research should expand beyond localized contexts and investigate gravity instruction across diverse educational settings. Larger experimental studies, longitudinal investigations, and cross-cultural comparisons are needed to establish broader evidence regarding the effectiveness and sustainability of innovative instructional approaches. Additional research examining teachers' pedagogical readiness and students' long-term conceptual retention would also contribute to the advancement of primary science education.

CONCLUSIONS

This systematic literature review synthesized evidence from nine studies published between 2021 and 2026 concerning the teaching of gravity concepts in primary science education. The findings identified four major themes: student-centered pedagogical approaches, digital and interactive learning media, experiential learning activities, and the introduction of Einsteinian perspectives. Collectively, these themes indicate that contemporary gravity instruction increasingly emphasizes active participation, multiple representations, and meaningful learning experiences to support students' conceptual understanding.

The review suggests that approaches such as demonstrations, Project-Based Learning, Problem-Based Learning, and experiment-based activities contribute positively to students' engagement and understanding of abstract gravitational phenomena. Likewise, digital technologies, including YouTube, Liveworksheet, and Augmented Reality, provide effective visualizations that help learners connect scientific concepts with observable experiences. Furthermore, emerging evidence indicates that simplified Einsteinian interpretations of gravity can be introduced at the primary level through age-appropriate pedagogical strategies, potentially enriching students' scientific literacy and broadening their perspectives on modern science.

Despite these promising findings, the evidence base remains limited by the relatively small number of available studies and their concentration in specific national contexts, particularly Indonesia. Future research should therefore conduct larger-scale, longitudinal, and cross-cultural investigations to examine the long-term effectiveness and transferability of innovative gravity teaching approaches. Additional studies focusing on teachers' pedagogical readiness and students' conceptual development are also needed to strengthen evidence-based practices in primary science education.

Overall, this review highlights the importance of integrating active learning strategies, digital technologies, experiential activities, and contemporary scientific perspectives to foster deeper and more meaningful understandings of gravity among primary school students. The findings provide valuable implications for teachers, researchers, and curriculum developers seeking to design engaging and effective science learning experiences for young learners.

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