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# Teaching Strategies in Physics Education: A Systematic Literature Review

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**Abstract:** Physics is a complex science discipline that intertwined with other disciplines (e.g. chemistry, life sciences, and mathematics), making it challenging for other learners to learn. To cope, educators developed strategies tailored to the needs of learners and their context. This article conducts a comprehensive systematic literature review of research articles available in Google Scholar that focuses on the concept of innovative strategies in teaching physics. Guided by the PRISMA model, 119 articles were identified, and of these, 31 articles were deemed relevant to the study. The result shows that the most used method in developing teaching strategies in physics is quasi-experimental followed by research and development. Result shows that physics education strategies are the most explored topic followed by physics laboratory innovations. Moreover, the recently published articles can be classified into two themes: non-digital teaching strategy and technology-aided teaching strategy. Outcomes of these developed strategies have shown improved learning among students and the development/enhancement of skills necessary in the 21st century such as problem-solving, analytical thinking, visualization, and social skills. Thus, this shows that the innovation of methodology-oriented new teaching strategies to address challenges in learning physics is crucial for improving conceptual understanding among learners.

**Keywords:** Learning physics; Physics concepts; Physics education; Scientific literacy; Teaching physics

## Introduction

A growing emphasis on the alignment of physics education in the 21st century skills highlight the need for active, learner-centered approaches to teaching physics (Bao & Koenig, 2019; Nazifah & Asrizal, 2020). Recent studies have continued to explore and refine strategies which includes using interactive homework as a tool to support student learning of measurement uncertainty in quantum mechanics (Passante & Kohnle, 2024), examining factors contributing to the improvement of conceptual understanding in Newtonian dynamics (Weber & Wilhelm, 2024), and focusing on knowledge integration in student learning of galvanic cells, bridging physics and chemistry (Ye et al., 2024), among others. As highlighted by Ma et al. (2023), teaching pedagogy have evolved with the intent to find approaches that fit the current social context and address the unique characteristics of students. In the context of Physics education, it is essential to implement innovations that accommodate the diverse learning needs of students and deepen their conceptual understanding.

The urgency of improving physics education is underscored by international assessments such as the Programme for International Student Assessment (PISA). The 2018 and 2022 PISA results indicate that several countries lag behind global benchmarks in mathematics and science proficiency (OECD, 2019,

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2023). Specifically, students' performance in Physics is notably below international standards (Martin et al., 2004; McLaughlin & Drori, 2000). The struggle with low student achievement has led educational researchers to consistently explore and determine the various factors that influence academic success in the classroom (Kuswanti, et al., 2024; Orleans, 1994; Zakirman et al., 2023). This highlights the critical need for research-based teaching strategies that foster deep learning and skill development in physics. Approaches such as flipped classrooms, inquiry-based learning, digital simulations, and augmented reality-enhanced instruction have demonstrated positive effects on student engagement and knowledge retention (Cai et al., 2021; Gunawan et al., 2018; Hasanah et al., 2021; Tunggyshbay et al., 2023). However, the effectiveness of these strategies varies across different educational contexts, necessitating a systematic review to identify best practices and their impact on student learning outcomes.

Thus, this study seeks to provide evidence-based strategies that can be implemented in the classrooms to foster a more effective and engaging learning environment for high school physics students. Additionally, the result of this study will provide insights for educators, administrators, curriculum developers, and policymakers in further refining and enhancing educational practices and policies. Furthermore, this study aims to determine the method employed, determine the physics topics explored in employing the developed teaching strategy and determine the general themes and outcomes of the employed teaching strategies.

## Method

*Materials and Data Source*

This study uses secondary data in the form of research articles to attain the objectives of the study. Moreover, the use of Google Scholar as a data source of research articles were selected by the researchers. This selection is based on Gusenbauer et al. (2020) idea that Google Scholar is one of the most comprehensive academic search engines which contains millions of records. In addition, the researchers employed the following inclusion criteria in searching the most suitable research articles to be included in the study. These include articles that can be found in google scholar, published between 2018 -2023, that the article is related to the keywords being used in the search, have an English version, have an available full text, are relevance to the study, and the article must be empirical research. The use of the following keywords was used by the researchers in finding the most suitable research articles; strategies in physics at the secondary level; teaching physics at the secondary level; teaching high school physics; and high school physics strategy. The selection of these keywords is based on the Cronin et al. (2008) idea that a good keywords for a literature review must be connected to the topic and have an alternative. Thus, in this study, the researchers created a keyword that is directly related to the topic of the study. In addition, the literature review was conducted from March to May 2024.

*Design and Procedure*

This study employed a systematic literature review (SLR) in addressing the objectives of the study. Nightingale (2009) pointed out that SLR addresses a specific question and is bounded by set criteria to minimize biases. In addition, SLR can also be useful to synthesize relevant scientific evidence to draw conclusions on the chosen topic (Lame, 2019). SLR is the most appropriate design for this study since this study focuses on obtaining the most recent innovations in teaching strategy in Physics through a literature review of the most recent published articles available in Google Scholar.

Moreover, the researchers followed the suggestions of Templier et al. (2015) in conducting literature review. This includes the following steps: Step 1. Formulating the problem - the objectives of the study focus on determining the outcomes of created physics teaching strategies. From these objectives, keywords were created to specifically address the main objectives of the study. Step 2. Searching the literature - using Google Scholar as the main search engine, keywords were individually searched. From the four keywords, a total of 119 research articles were downloaded and for screening (strategies in physics at the secondary level = 43 articles; teaching physics at the secondary level = 36 articles; teaching high school physics = 23 articles; and high school physics strategy = 17 articles). Step 3. Inclusion criteria - the downloaded articles were screened based on the set inclusion criteria of the study and other crucial information such as a focus on the topic, lack of empirical findings, and no clear discussion of the topic. Step 4. Assessing quality - the downloaded articles were screened based on the quality of the paper and its relevance to the study. These step include selecting only research articles published by peer-reviewed journals, articles with concrete findings based on the objectives of their respective studies, clear methodology, can answer the objectives of the study, and finally are bounded by the inclusion criteria set by this study. Step 5. Extracting data - a total of 31 articles were included and deemed relevant to the study. Thus, a content analysis was used in the study to extract the most crucial data from the downloaded articles. Harwood et al. (2003) have pointed out that content analysis is useful in reducing phenomena to better analyze and interpret the data. Step 6. Analyzing and synthesizing data - analysis and synthesis of data were done after the extraction of the data.

In addition, the researchers employed the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) flow diagram to organize the analysis (Moher et al., 2009) as seen in Figure 1. This method ensures that a thorough process is done to obtain and collect the necessary data. In the identification phase, a total of 119 articles which can be seen in Google Scholar are included (based on keywords). In the screening phase, a total of 42 articles were retained after removing 77 research articles based on the following limitations; 11 research articles removed due to duplication, 11 articles are removed primarily because these articles don't have a full free version and only give the summary of the research paper, 5 articles are removed because these articles are not in English, 6 articles are removed due to unclear discussion of the physics concepts used such as the use of the general term "science" or "general science", 5 articles are removed because these articles focuses in STEM in general, thus covering the broad field such as technology, science, and mathematics discipline, 14 articles are removed due to these articles are not directly related to the topic of this study such as focuses on what is physics rather than how to teach physics, and lastly 25 articles are removed because the articles focuses only on the nature of physics learning but not on the strategy employed to improve physics learnings.

Moreover, in eligibility checking, 31 articles are retained after removing 11 articles. The following are the basis for this removal: 8 of these removed articles have vague findings and therefore cannot provide a good discussion on the argument of their research, while 3 articles were removed because these articles focuses the discussion on the results itself rather than the implications of the findings. Thus, a total of 31 articles were included in the study after the screening and eligibility checking.

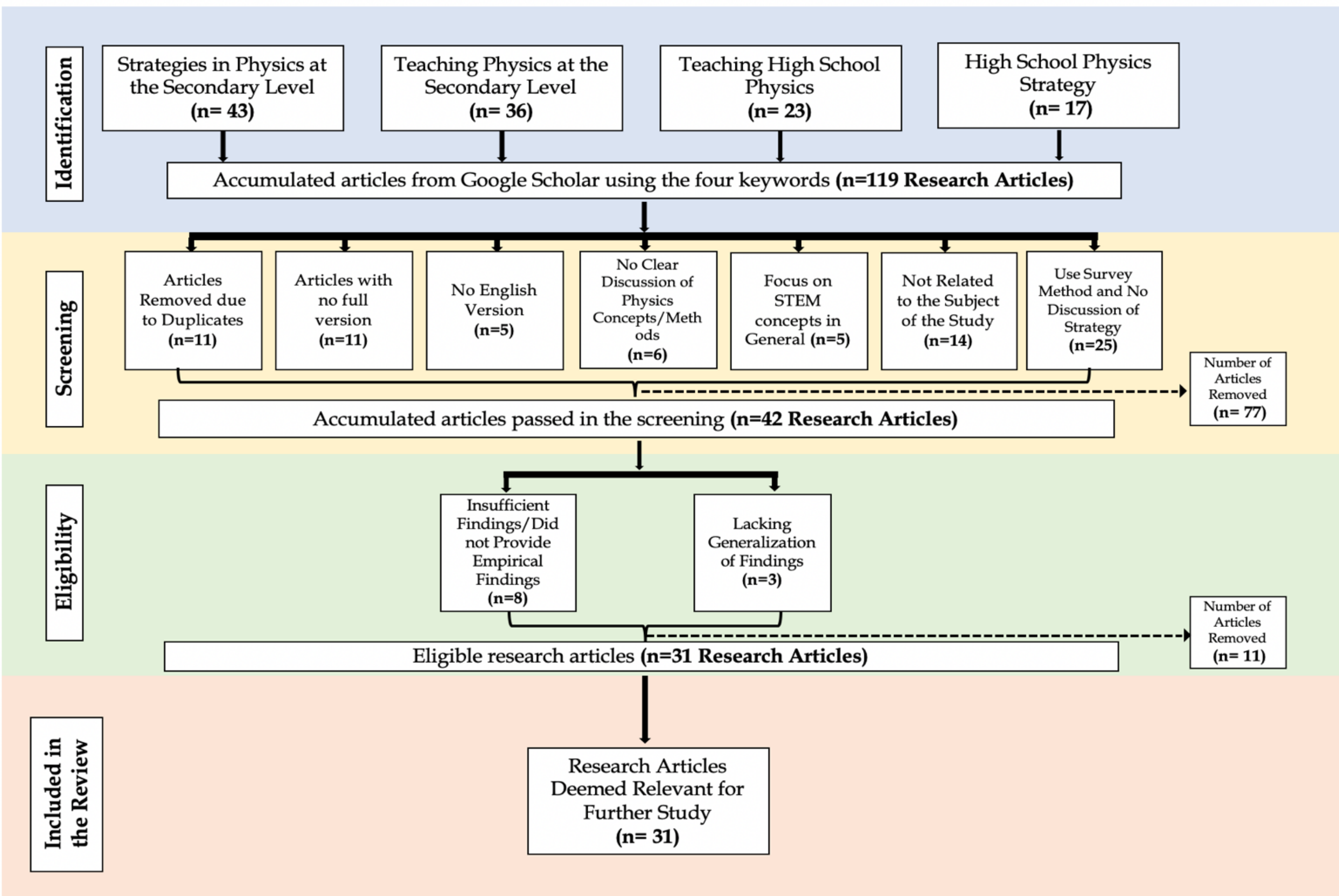


**Figure 1.** Selection of articles based on the PRISMA model

*Data Analysis*

This study used content and thematic analysis to analyze the gathered documents. Content analysis was used to uncover the presence of words and concepts pertaining to the objectives of the study. Krippendorff (2018) noted that this method of analysis involves the evaluation of document content and tabulating the relevant information to yield meaningful findings. In this study, this method is used to address the first and second objectives of the study. In addition, thematic analysis is also used to address the third objective of the study. Braun et al. (2012) have noted that this method of analysis is used primarily in identifying patterns, organizing these patterns, and giving meaning to these patterns. Therefore, this method of analysis is helpful in addressing the objective of the study.

## Results and Discussion

This section focuses on the main findings and discussion of the study and is organized based on the objectives of the study. Discussion includes the findings on the method used by the research articles, the physics topic explored, and general themes and outcomes of these research articles.

Based on the analysis of 31 systematically reviewed articles, the most frequently employed research method is quasi-experimental design (58.06%), which is widely used for assessing the effectiveness of teaching interventions through pre-test and post-test comparisons (Miller et al., 2020). This method is particularly valuable in physics education, where instructional innovations require quantifiable evidence of impact on student learning (Gopalan et al., 2020).

Additionally, research and development (16.13%) has gained popularity for designing new instructional models aimed at improving students' comprehension of complex physics concepts (Atmowardoyo, 2018). Other methodologies, including case studies (6.45%), action research (6.45%), experimental designs (6.45%), pre-experimental (3.23%), and quantitative-descriptive methods (3.23%), contribute to understanding various dimensions of teaching effectiveness and student engagement (see Table 1).

In physics education, the call to develop new teaching strategy (Jolly et al., 2009), innovative teaching physics training (Zavala et al., 2007), and develop readiness in teaching physics (Jugembayeva & Murzagaliyeva, 2022) are among the needed topics to address the complexity of this discipline. Thus, with the use of research and development, there will be more innovative solutions to address gaps in teaching physics.

**Table 1.** Method Employed by the Study

| Method | f | % | Author |
|---|---|---|---|
| Quasi-Experimental | 18 | 58.06 | (Achor & Abuh, 2020; Al Sultan, 2023; Baran et al., 2018; Citra et al., 2020; Fidar & Tuncel, 2019; Gunawan et al., 2018; Hochberg et al., 2018; Maknun, 2020 Nafiah et al., 2023; Ojo & Owolabi, 2020; Omokorede & Siyelnen, 2021; Sanggara et al., 2018; Santyasa et al., 2018, 2020; Sari et al., 2019; Suliswоro et al., 2018 Suwarna & Fatimah, 2019; Zain & Jumadi, 2018 |
| Research and Development | 5 | 16.13 | (Arista & Kuswanto, 2018; Buhungo et al., 2023; Dasilva et al., 2019; Fitriadi et al. 2022; Liliarti & Kuswanto, 2018 |
| Action Research | 2 | 6.45 | (Fayanto et al., 2019; Hernández-Suárez et al., 2020 |
| Case Study | 2 | 6.45 | (Bogusevschi et al., 2020; Ramma et al., 2018 |
| Experimental Design | 2 | 6.45 | (Cai et al., 2021; Saputra & Kuswanto, 2019 |
| Pre-Experimental | 1 | 3.23 | (Ndoa & Jumadi, 2022 |
| Quantitative-Descriptive | 1 | 3.23 | (Alif Syaiful Adam, 2022 |

Table 2 shows that topics explored in the new innovations in teaching Physics. Based on the analysis, it was found that most studies focused on physics education strategies (19.35%), with an emphasis on developing active learning environments and improving conceptual understanding (Santyasa et al., 2018). Physics laboratory innovations (12.90%) were the second most explored area, reflecting the increasing use of virtual laboratories and technology-assisted experimental learning (Gunawan et al., 2018; Arista & Kuswanto, 2018). Newton's Laws (9.68%) received significant attention, particularly in studies addressing student misconceptions and problem-solving techniques (Baran et al., 2018; Saputra & Kuswanto, 2019). Similarly, oscillations and elasticity (16.13%) were explored using interactive digital tools, aiding visualization and practical application of concepts (Fitriadi et al., 2022; Hochberg et al., 2018). Notably, underrepresented physics topics, such as photoelectric effects, thermodynamics, static electricity, and fluid dynamics, indicate research gaps where further instructional innovations are needed. This shows that innovative teaching of physics is not just confined to one topic but also cascaded to other topics (Campos et al., 2020). This is very crucial, especially since physics comprises different sub-disciplines (Jena & Castleman, 2006; You & Nori, 2011).

Table 3 shows the topics explored in the new innovations in teaching Physics. Based on the analysis, there were two main themes: non-digital teaching strategy and technology-aided teaching strategy. non-digital teaching strategy include concept mapping, direct instruction, guided inquiry, and project-based learning, all of which have demonstrated effectiveness in enhancing students' conceptual understanding and engagement in problem-solving tasks (Santyasa et al., 2018). Technology-aided strategies, such as augmented reality, mobile learning, virtual physics laboratories, and digital assessments, provide interactive learning experiences that improve students' retention, cognitive skills, and problem-solving abilities (Gunawan et al., 2018; Fitriadi et al., 2022).

**Table 2.** Explored Topics in Innovating Teaching Strategies in Physics

| Topic | f | % | Authors |
|---|---|---|---|
| Physics Education Strategies | 6 | 19.35 | (Al Sultan, 2023; Fidan & Tuncel, 2019; Liliarti & Kuswanto, 2018; Ndoa & Jumadi, 2022; Omokorede & Siyelnen, 2021; Santyasa et al., 2018) |
| Physics Laboratory Innovations | 4 | 12.90 | (Arista & Kuswanto, 2018; Bogusevschi et al., 2020; Gunawan et al., 2018; Sanggara et al., 2018) |
| Newton's Law | 3 | 9.68 | (Baran et al., 2018; Saputra & Kuswanto, 2019; Suwarna & Fatimah, 2019) |
| Oscillations | 3 | 9.68 | (Alif Syaiful Adam, 2022; Fitriadi et al., 2022; Hochberg et al., 2018) |
| Elasticity | 2 | 6.45 | (Buhungo et al., 2023; Sulisworo et al., 2018) |
| Light | 1 | 3.23 | (Fayanto et al., 2019) |
| Measurement and Motion | 1 | 3.23 | (Ramma et al., 2018) |
| Mechanical Physics | 1 | 3.23 | (Hernández-Suárez et al., 2020) |
| Motion and Force | 1 | 3.23 | (Santyasa et al., 2018) |
| Newtons Law of Motion, work and energy, impulse and momentum, thermodynamics, and characteristics of mechanical wave. | 1 | 3.23 | (Dasilva et al., 2019) |
| Optics | 1 | 3.23 | (Zain & Jumadi, 2018) |
| Parabolic Motion | 1 | 3.23 | (Nafiah et al., 2023) |
| Photoelectric Effect | 1 | 3.23 | (Cai et al., 2021) |
| Physics Analogical Transfer Skill | 1 | 3.23 | (Sari et al., 2019) |
| Physics Practical | 1 | 3.23 | (Ojo & Owolabi, 2020) |
| Static Electricity Material | 1 | 3.23 | (Citra et al., 2020) |
| Thermal Physics | 1 | 3.23 | (Achor & Abuh, 2020) |
| Static Fluid | 1 | 3.23 | (Maknun, 2020) |

**Table 3.** Themes and Outcomes of the Innovative Teaching Strategies in Physics

| Theme of Strategy | Teaching Strategy | Topic | Author |
|---|---|---|---|
| | Conceptual Change Pedagogy | Thermal Physics | (Achor & Abuh, 2020) |
| | Concept Map | Mechanical Physics Concepts | (Hernández-Suárez et al., 2020) |
| | Conceptual Change Model | Motion and Force | (Santyasa et al., 2018) |
| | Direct instruction model using multimedia | Light | (Fayanto et al., 2019) |
| | Guided Inquiry Leaning Model | Static Fluid | (Maknun, 2020) |
| Non-Digital Teaching Strategy | Jigsaw instructional strategy (JIS) | Physics Education | (Omokorede & Siyelnen, 2021) |
| | Learning Cycle 7E | Parabolic Motion | (Nafiah et al., 2023) |
| | Multiple Representations Based Teaching Material | Static Electricity Material | (Citra et al., 2020) |
| | Predict, Organize, Search, Summarize, and Evaluate(POSSE) strategy | Physics Education | (Al Sultan, 2023) |
| | Project-Based Learning | Parabolic Motion | (Nafiah et al., 2023) |
| | | Physics Education | (Santyasa et al., 2020) |
| | Project-Based Learning Game Technique | Newton's Law of Motion | (Baran et al., 2018) |
| | Android-Based Earning Media with Local Cultural Content | Physics Concepts (Diagramming and Argumentative Representation) | (Liliarti & Kuswanto, 2018) |
| Technology-Aided Teaching Strategy | Android-Based Interactive Physics Mobile Learning Media (IPMLM) with Scaffolding Learning Approach | Newtons Law of Motion, work and energy, impulse and momentum, thermodynamics, and characteristics of mechanical wave. | (Dasilva et al., 2019) |
| | Augmented Reality - AROSE (Augment Reality Optical Simulation Experiments) | Photoelectric Effect | (Cai et al., 2021) |

| | | |
|---|---|---|
| Contextualized Teaching and Learning (CTL)-Based E-Book | Simple Harmonic Oscillation | (Fitriadi et al., 2022) |
| Digital Assignments | Newton's Law | (Suwarna & Fatimah, 2019) |
| Flipped Learning-Based Physics E-Module | Physics Education | (Ndoa & Jumadi, 2022) |
| Guided Inquiry Based on Blended Learning | Optics | (Zain & Jumadi, 2018) |
| Isomorphic | Physics Analogical Transfer Skill (momentum and impulses) | (Sari et al., 2019) |
| Physics (FORFIS) application | | |
| Line@ Social media application | Elasticity | (Sulisworo et al., 2018) |
| Physics Mobile Learning (PML) with HomboBatu theme smartphone android-assisted | Newton's Law | (Saputra & Kuswanto, 2019) |
| Physics Pop-Up Question Video | Oscillation | (Alif Syaiful Adam, 2022) |
| Problem-Based Leaning Assisted with Augmented Reality | Physics Education | (Fidan & Tuncel, 2019) |
| Process Oriented Guided Inquiry Learning | Physics Laboratory | (Sanggara et al., 2018) |
| Model Based On Virtual Laboratory | | |
| Quality Physics Learning Tools Using Problem-Based Learning (Contextualized Learning Approach) | Elasticity and Hooke's Law | (Buhungo et al., 2023) |
| Smartphone as Experimental Tools (Smartphones' Acceleration Sensors) | Harmonic Mechanic Oscillations (i.e. pendulum movements) | (Hochberg et al., 2018) |
| Technology Integration in the Affective Domain (Pedagogical Technological Integrated Medium (PTIM)). | Measurement and Motion | (Ramma et al., 2018) |
| Virtual Laboratory Media | Physics Laboratory | (Gunawan et al., 2018) |
| Virtual Physics Laboratory Application (ViPhyLab Application) | Physics Laboratory | (Arista & Kuswanto, 2018) |
| Virtual Reality and Virtual Laboratory (Water Cycle in Nature Application) | Physics Laboratory | (Bogusevschi et al., 2020) |
| Virtual Laboratory Instructional Strategy | Physics Practical | (Ojo & Owolabi, 2020) |

Among the non-digital teaching strategy, studies found that guided inquiry and conceptual change models significantly help students correct misconceptions and develop deeper physics comprehension (Maknun, 2020). Project-based learning, applied in studies on Newtonian mechanics and motion, has been shown to improve students' problem-solving and analytical thinking abilities (Baran et al., 2018). However, direct instruction models, though effective for structured content delivery, exhibited lower engagement levels compared to interactive models, suggesting a need for supplementary active learning techniques (Santyasa et al., 2020).

The review also highlights the increasing integration of technology-enhanced teaching methods, with virtual laboratories and mobile learning applications being particularly effective in making abstract physics concepts more tangible (Ahmad et al., 2024; Arista & Kuswanto, 2018; Yolanda et al., 2025). Studies incorporating augmented reality in physics education reported notable improvements in students' visualization skills, particularly in photoelectric effects and thermodynamics—topics traditionally challenging for students to grasp (Cai et al., 2021). Additionally, digital physics simulations have been successful in reinforcing problem-solving strategies, as demonstrated in research focusing on elasticity and harmonic oscillations (Hochberg et al., 2018). While technology-aided instruction consistently enhances engagement and conceptual understanding, it also presents challenges in accessibility and implementation, requiring teachers to be well-equipped with the skills necessary for integrating digital tools (Ellermeijer & Tran, 2019). Future research could further explore blended learning models, combining non-digital teaching strategy with digital enhancements to maximize learning effectiveness across diverse physics topics.

Moreover, the reviewed studies emphasize that physics education innovations contribute directly to the development of 21st-century skills (Soh et al., 2010), notably in complex-reasoning competencies and auto-systemic thinking to support problem-solving and address social needs (González-Pérez & Ramírez-Montoya, 2022). These competencies align with modern educational frameworks, which prioritize interactive, student-centered learning approaches that encourage critical thinking, collaboration, and creativity (Zain & Jumadi, 2018).

Figure 1 represents the key outcomes from the systematic review of teaching strategies in physics education, highlighting the most frequently studied concepts related to student learning, skills development, and conceptual understanding. The most prominent terms—learning, conceptual understanding, problem-solving, thinking, skill development—reflect recurring themes in the 31 reviewed articles, demonstrating how innovative instructional methods enhance student competencies.


**Figure 1.** Outcomes of the articles in teaching physics

The reviewed studies indicate that problem-solving is a central learning outcome of various teaching strategies, particularly in research on guided inquiry, project-based learning, and digital simulations (Maknun, 2020; Santyasa et al., 2018). Conceptual understanding also emerged as a key focus, with studies finding that students engaging in active learning environments show significant improvement in grasping fundamental physics principles (Baran et al., 2018). Additionally, strategies incorporating mobile learning, virtual laboratories, and augmented reality have demonstrated positive effects on student engagement and self-efficacy, particularly in complex topics such as oscillations, Newtonian mechanics, and thermodynamics (Gunawan et al., 2018; Cai et al., 2021).

Moreover, the emphasis on creativity and enthusiasm in physics learning suggests that strategies promoting student-centered exploration, interactive learning tools, and inquiry-based activities contribute to higher motivation and participation in the subject (Cadiz et al., 2023; Fidan & Tuncel, 2019; Zulfaniar et al., 2024). The systematic review confirms that students exposed to technology-aided teaching methods exhibit increased curiosity and deeper engagement, aligning with 21st-century education frameworks emphasizing interactive, student-driven learning (González-Pérez & Ramírez-Montoya, 2022).

These key findings summarize and give importance to the effectiveness of the developed teaching strategies in physics for basic education learners. It can be generalized that the outcomes of these developed strategies are not just limited to the enhancement of learning but served as a generation of skills. Though there are topics in physics that needs to be explored, such as universal gravitation, general relativity, fluid mechanics, wave phenomena, and the application of digital simulations in advanced physics concepts, the current studies provide enough information for other studies on the processes how to create new innovations. Thus, the current research significantly contributed to the body of knowledge specially in the realm of physics education.

## Conclusion

Teaching physics can be a challenge to some educators, primarily in how to deliver the lesson well to diverse groups of learners in the classroom. To alleviate this, physics educators have created an innovative teaching strategy designed to address specific learning challenges in this discipline. The used of a systematic literature review was used to uncover the method used, explored topics, the general themes of developed teaching strategies, and their outcomes were studied in the paper. Guided by the PRISMA mode, 119 research articles on innovative strategies in teaching physics were identified; of these, only 31 articles qualified and were used in the analysis. Findings of the study highlight that of the 31 research articles, 18 (58.06%) used a quasi-experimental method. This shows that educators measure the applicability and relevance of their developed strategy through testing in a controlled setup. Allowing them to provide feedback on the effectiveness of their developed strategy to address a certain challenge/issue in teaching physics. In terms of the topics explored, 6 (19.25%) research articles studied physics education strategies emphasizing the importance of developing salient concepts in teaching physics. Moreover, themes of these created teaching strategies can be classified into non-digital teaching strategies and technology-aided teaching strategies, highlighting the evolving landscape of teaching in the 21$^{st}$-century education. Outcomes of these developed teaching strategies include the development/enhancement of students' 21$^{st}$-century skills such as problem-solving, analytical thinking, visualization, and social skills. From these findings, this research provides insights into areas for further investigation in the realm of innovative teaching strategies in Physics. First, educators and researchers can explore other methods such; as any form of qualitative method, to explore the experiences of learners in the developed strategy, or any form of mixed methods to add more rigor, to name a few. Second, exploring other topics in physics such as universal gravitation, general relativity, concepts of fluid mechanics, wave phenomena, and the application of digital simulations in advanced physics concepts, and other concepts that pose a challenge for learners to relate due to their complex nature and are less well documented in the literature. Third, develop new teaching strategies that cater other competencies, especially the needed competencies in the 21$^{st}$-century and the current society (industry 4.0 and industry 5.0).

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The authors declare no conflict of interest.

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