Kaffah 1 (2), 2025

KAFFAH INTERNATIONAL JOURNAL OF ISLAMIC STUDIES AND EDUCATION

https://ejournal.lembagaeinsteincollege.com/KAFFAH/

The Dick, Carey, and Carey Design Model in Physics Education: Literature Review and Implementation Studies

Holis Angga Saputra[1*], Ni Putu Anindita Dara Maheswari[1], Gina Harnum Fatina[1], Satutik Rahayu[1]

[1]Master of Science Education, Postgraduate, University of Mataram, Mataram, Indonesia.

Article Info:

Received : 01 August 2025
Revisied : 03 September 2025
Accepted : 25 October 2025
Published : 05 November 2025

Corresponding Author:
Holis Angga Saputra
hlsagga@gmail.com

Keyword:
Instructional Design; Dick and Carey Model; Physics Education; Systematic Literature Review; Educational Technology.

Abstract: This study examines the application of the Dick, Carey, and Carey instructional design model in physics education through a systematic literature review. The study aims to analyze patterns of procedural implementation, identify key strengths and limitations of the model, and examine its adaptation in conjunction with contemporary educational technologies. The methodology employed a systematic review of peer-reviewed scientific publications, with a focus on development-based research and empirical implementation studies. The findings reveal that the model is predominantly applied according to its ten procedural stages, offering a structured, goal-oriented framework that facilitates strong alignment among learning objectives, instructional strategies, and assessment practices. The principal strength of the model lies in its systematic and coherent structure, whereas its main limitation is its perceived rigidity and linearity, which may constrain flexibility in highly dynamic learning contexts. Notably, the results demonstrate the model's considerable adaptability, as it is frequently integrated with modern technologies, including Augmented Reality (AR), e-modules, and TPACK-based instructional frameworks. Such integrations contribute to enhanced student engagement and underscore the model's continued relevance in contemporary physics education. The study concludes that the Dick, Carey, and Carey model remains a valid and effective framework for instructional design in physics, particularly when its systematic approach is complemented by technological innovations.

How to Cite : Saputra, H., Maheswari, N. P. A. D., Fatina, G. H., & Rahayu, S. (2025). The Dick, Carey, and Carey Design Model in Physics Education: Literature Review and Implementation Studies. *KAFFAH: International Journal of Islamic Studies and Education*, *1*(2), 39-44. https://ejournal.lembagaeinsteincollege.com/KAFFAH/article/view/226

INTRODUCTION

In many educational environments, instructional design remains underdeveloped—often inconsistent, unstructured, and reliant on instructor intuition. This can lead to passive learning and low student motivation, as learners become disengaged from unstructured or monotonous teaching methods (Nugraha et al., 2023; Setiadi et al., 2022). The primary issue is a poor alignment between learning goals, activities, and assessments, which ultimately compromises instructional effectiveness and relevancy (Dick & Carey, 2015). Designers frequently struggle with linking these instructional components into a coherent whole, a challenge observed across diverse

disciplines from Islamic Education (Nugraha et al., 2024) to university-level statistics courses (Suradika et al., 2022).

The Dick, Carey & Carey systems model offers a structured remedy by treating instructional design as an integrated system of interrelated components. It has been described as a "game-changer" for its potential to enhance academic achievement through its systematic, step-by-step process (Adeoye et al., 2024). The model guides designers through a logical sequence of goals, analysis, objectives, strategies, materials, and evaluation. Its iterative, data-informed process, which integrates formative and summative evaluation, promotes data-driven decision making and adaptability to learner needs, making it particularly well-suited for structured, school-based research (D'Angelo et al., 2018; Dick, Carey, & Carey, 1978). By providing a clear and organized pathway, the model not only enhances student learning outcomes but also improves motivation by making the instructional process transparent and purposeful (Nugraha et al., 2023). This systematic approach is also valuable for developing complex competencies, including 21st-century skills, positioning it as a robust framework for addressing modern educational challenges (Toker, 2022).

METHOD

This study utilizes a Systematic Literature Review (SLR) to conduct a comprehensive analysis and synthesis of scientific literature concerning the application of the Dick, Carey, and Carey Design Model within physics education. The SLR methodology was selected to ensure a systematic, transparent, and verifiable review process, adhering to the framework established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Research questions. The inquiry is guided by the following research questions, which are formulated to investigate the model's implementation in depth: RQ1: How are the procedural stages of the Dick, Carey, and Carey Model implemented in empirical studies within physics education?, RQ2: What are the reported advantages and positive outcomes of applying this model, particularly in comparison to other instructional design models?, RQ3: What are the identified limitations, challenges, and criticisms of the model, especially within modern, technology-enhanced learning environments?, RQ4: What patterns of technological adaptation and innovation, such as Augmented Reality and HOTS-focused videos, are integrated into the model's implementation?

Search strategy and data sources. The data sources for this review primarily consist of a curated collection of key studies identified by the researcher as germane to the topic. A supplementary literature search was executed on academic databases, including Google Scholar and Scopus, to ensure comprehensive coverage and mitigate selection bias. The temporal scope of the analyzed publications spans from 2009 to 2025, thereby encompassing both foundational and contemporary research.

Study selection criteria. The literature included in this review was selected based on a predefined set of criteria:

Inclusion Criteria:

The study explicitly discusses, applies, or presents a critical analysis of the Dick, Carey, and Carey Model. The research context is pertinent to education, with a specific focus on physics or general science education. The study involves empirical implementation, the development of instructional materials (e.g., modules, worksheets, digital media), or a comparative analysis of the model. Publication types include peer-reviewed journal articles, conference proceedings, and scholarly books.

Exclusion Criteria:

Studies that provide only a cursory mention of the model without substantive analysis. Studies whose context is irrelevant to education or instructional design.

Data extraction and synthesis.

The analysis and synthesis of data from the selected literature were conducted via a dual-pronged approach: Component-Basxd Procedural Analysis: To address RQ1, the model's implementation as reported in the selected studies was systematically mapped onto its ten procedural

components. This process entailed extracting data on the practical execution of each stage—from needs analysis to summative evaluation—including the specific instruments and design decisions employed. Cross-Study Thematic Synthesis: To address RQ2, RQ3, and RQ4, a thematic synthesis was performed to identify overarching patterns and conceptual themes across the body of literature. Advantages and Limitations (RQ2 & RQ3): This theme was derived from comparative studies that contrast the model with alternatives and from critical analyses discussing its application challenges in modern educational settings. Technological Adaptation (RQ4): This theme focuses on the innovation and integration of technology reported in the literature, such as the use of Augmented Reality, videos for fostering Higher-Order Thinking Skills (HOTS), and web-based instructional platforms. Affective Implications: Insights from relevant meta-analytic research were incorporated to enrich the discussion regarding the importance of considering student beliefs and attitudes, an area often highlighted for the model's further development.

This integrated analytical approach facilitates a robust synthesis that clarifies not only how the model is applied but also the rationale and outcomes of its application within the contemporary landscape physics education.

RESULT AND DISCUSSION

What is The Dick, Carey and Carey Model?

The Dick, Carey, and Carey model, also known as the Systems Approach Model, is a comprehensive framework for designing, developing, implementing, and evaluating instruction. The model views instruction as an "interrelated system," where all components work together toward a defined goal and use feedback to determine whether the desired goal has been achieved (Askar & Djono, 2025). If the goals have not been met, the system will be modified until they are.

The model is not an isolated concept but is built on a strong theoretical foundation of learning psychology, with each component based on theory and, in many cases, on research proving its effectiveness (Dick & Carey, 2015).

Integration and Adaption of The Model

This model has been successfully integrated across educational levels and subject areas by adapting its general workflow to contextual needs. Its application in various educational settings—from physics and statistics to Islamic Religious Education—demonstrates its procedural yet adaptable nature (Masruroh, 2023; Nugraha et al., 2024; Suradika et al., 2022).

Components and Main Procedures

The main steps of the model, as applied consistently in various development studies (e.g., Hutabarat et al., 2015; Nissa et al., 2023; Setiadi et al., 2022), include:

Identifying instructional goals & analyzing needs. At this stage, designers formulate specific and relevant instructional objectives. This initial investigation includes an analysis of the curriculum, student needs, and practical problems to ensure that the objectives are clear and achievable (Suradika et al., 2022). For example, the study by Wati et al. (2024) designed a physics laboratory module with HOTS videos to support the establishment of more precise learning objectives.

Analyzing learners and contexts. This stage involves collecting data on the characteristics of learners, such as their academic background, learning styles, and prior knowledge (Setiadi et al., 2022). Research by Dikmen (2019) shows that such analysis is important before designing web-based instruction. Contextual factors are also evaluated, leading to innovative solutions like the use of Augmented Reality (AR) to help visualize abstract concepts (Nissa et al., 2023).

Writing performance objectives. Based on the previous analysis, researchers design concrete and durable performance objectives. These objectives often follow the ABCD (Audience, Behavior, Condition, Degree) formula to ensure clarity and measurability (Askar & Djono, 2025; Setiadi et al., 2022). This step ensures that every learning activity directly supports the established objectives, strengthening the alignment between objectives, strategies, and evaluation.

Developing assessment instruments. Assessment instruments are developed to measure the attainment of objectives. These include objective tests, performance rubrics, and,

commonly, pre-tests and post-tests to measure improvements in student academic achievement (Hutabarat et al., 2015; Nuraini et al., 2022; Setiadi et al., 2022). **Developing instructional strategy.** In this step, a comprehensive instructional plan is crafted, integrating various modes and technologies. According to Bakri & Dwijayanti (2022), this can include AR-enhanced demonstrations and interactive problem-solving. This aligns with the model's emphasis on designing instruction that supports measurable objectives and is attuned to learners' contexts (Adeoye et al., 2024).

Developing and selecting instructional materials. Materials such as interactive modules, textbooks, and worksheets are selected or developed based on the chosen strategy. Successful examples include a physics textbook for vocational schools (Hutabarat et al., 2015), an e-module using CMS WordPress (Nuraini et al., 2022), and a textbook on static fluids using AR (Nissa et al., 2023).

Designing and conducting formative evaluation. Formative evaluation is conducted through limited trials—such as one-on-one, small group, and field trials—to gather data on the program's weaknesses and strengths (Askar & Djono, 2025; Hutabarat et al., 2015). These results are then used as the basis for revision.

Revising instruction. In the Dick and Carey model, revising instruction is a crucial reflective mechanism. As argued by Srimularahmah and Mantasiah (2025), revisions in this model are based on empirical data, making learning more adaptive. This shows that the model is not static, but dynamic and responsive to learning evaluations (Masruroh, 2023).

Designing and conducting summative evaluation. Summative evaluation is designed to measure the achievement of performance objectives after full implementation. It is often conducted by an independent party to ensure objectivity (Askar & Djono, 2025). Statistical analysis of pre-test and post-test scores is a common method to demonstrate the model's overall effectiveness (Hutabarat et al., 2015; Setiadi et al., 2022).

Summative evaluation feedback and revision for future use. From the summative results, researchers conclude the effectiveness of instruction and identify areas for further development. This feedback is used to revise the curriculum and modules in subsequent research cycles.

Goals of The Development Model

The primary goal is to ensure learners reliably achieve target competencies through instruction that is evidence-based and systematically aligned. By framing objectives clearly, linking them to assessment and instruction, and employing iterative evaluation, the model is considered a "game-changer" in enhancing academic achievement (Adeoye et al., 2024) and improving student motivation (Nugraha et al., 2023).

Advantages and Limitations over Other Models

The Dick and Carey instructional design model offers distinct advantages due to its systematic and goal-oriented structure. This systematic integration helps ensure coherence across all learning components (Masruroh, 2023; Askar & Djono, 2025). Despite its strengths, the model also presents notable limitations. One major criticism is its linear and rigid nature. When compared to more agile models like Rapid Prototyping, the Dick and Carey model may be perceived as more time-consuming and less adaptable for dynamic environments that require frequent iteration (Toker, 2022; Chen, 2016).

CONCLUSIONS

Based on the systematic literature review and analysis, several conclusions can be drawn regarding the application of the Dick, Carey, and Carey model in physics education. First, the model is consistently implemented through its ten procedural steps, serving as a reliable and comprehensive framework for designing and developing instructional materials, from textbooks to digital e-modules. Second, the model's primary advantage lies in its systematic, goal-oriented nature, which enforces a strong coherence between learning objectives, instructional strategies, and assessment instruments. This structured approach is highly effective for ensuring instructional quality and accountability.

Conversely, the main limitation identified in the literature is the model's perceived linearity and rigidity, which can be less suitable for dynamic,

technology-driven learning environments that demand greater flexibility. However, this study finds that this limitation is effectively mitigated by a significant trend of technological adaptation. The model has proven to be highly adaptable, with numerous studies demonstrating its successful integration with modern tools such as Augmented Reality (AR), interactive e-modules, and pedagogical frameworks like TPACK. These adaptations not only overcome the model's structural constraints but also enhance its effectiveness in visualizing abstract physics concepts and engaging modern learners.

Therefore, this review concludes that the Dick, Carey, and Carey model, despite its age, remains a highly relevant and valuable framework in physics education. Its enduring utility is found in its solid, systematic foundation, which, when combined with contemporary technological innovations, provides a powerful tool for creating effective and engaging learning experiences. Future research could focus on direct comparative studies between this model and more agile instructional design methodologies in technology-rich settings.

ACKNOWLEDGMENTS

The author would like to express sincere gratitude to Dr. Satutik Rahayu, M.Pd., the lecturer for the "Desain Model Pembelajaran IPA" course, for her invaluable guidance, insightful feedback, and unwavering support during the preparation of this article.

AUTHOR CONTRIBUTIONS

Conceptualization, S.R. and H.A.S.; methodology, H.A.S. and N.P.A.D.M.; software, G.H.F.; validation, S.R., H.A.S. and N.P.A.D.M.; formal analysis, H.A.S. and N.P.A.D.M.; investigation, H.A.S., N.P.A.D.M. and G.H.F.; resources, S.R.; data curation, G.H.F.; writing—original draft preparation, H.A.S., N.P.A.D.M. and G.H.F.; writing—review and editing, S.R.; visualization, N.P.A.D.M.; supervision, S.R.; project administration, S.R.; funding acquisition, S.R. All authors have read and agreed to the published version of the manuscript.

FUNDING

This research received no external funding

CONFLICTS OF INTEREST

The authors declare no conflict of interest

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