



GLOBAL RESEARCH TRENDS ON THE ADDIE DEVELOPMENT MODEL IN MATHEMATICS EDUCATION: A BIBLIOMETRIC ANALYSIS

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ABSTRAK

Pendidikan memiliki peran penting dalam menciptakan sumber daya manusia yang berkualitas, terutama dalam pembelajaran matematika yang sering dianggap menantang. Pengembangan perangkat pembelajaran yang relevan merupakan solusi utama untuk meningkatkan kualitas pembelajaran. Artikel ini mengulas penggunaan model ADDIE (Analysis, Design, Development, Implementation, Evaluation) dalam pengembangan perangkat pembelajaran matematika. Model ini menawarkan kerangka kerja yang sistematis dan iteratif untuk merancang pembelajaran yang kontekstual dan interaktif. Penelitian ini menggunakan kerangka PRISMA untuk observasi sistematis terhadap 32 artikel yang dipublikasikan antara 2014 hingga 2024, yang mencakup distribusi publikasi, penerapan ADDIE dalam berbagai konteks, dan tren global dalam pengembangan perangkat pembelajaran. Hasil penelitian menunjukkan bahwa ADDIE banyak diterapkan, disesuaikan dengan kebutuhan lokal, seperti integrasi teknologi di negara maju dan pendekatan sumber daya minimal di negara berkembang. Model ini terbukti dapat meningkatkan hasil belajar siswa, meskipun tantangan seperti keterbatasan waktu dan sumber daya tetap ada. Penelitian ini merekomendasikan untuk mengoptimalkan ADDIE dalam inovasi pembelajaran berbasis siswa.

ABSTRACT

Education plays an important role in creating quality human resources, especially in mathematics learning which is often considered challenging. The development of relevant open devices is the main solution to improve the quality of learning. This

article reviews the use of the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model in the development of mathematics teaching devices. This model offers a systematic and iterative framework for designing contextual and interactive learning. The study used the PRISMA framework for systematic observation of 32 articles published in 2014-2024, covering publication distribution, ADDIE implementation in various contexts, and global trends in teaching device development. The results show that ADDIE is widely applied, adjusted to local needs, such as technology integration in developed countries and minimal resource approaches in developing countries. This model has been shown to improve student learning outcomes, although challenges such as time and resource constraints remain. The study recommends optimizing ADDIE for student-based learning innovations.

1. INTRODUCTION

Education serves as the cornerstone in creating high-quality human resources (Pathiranage & Karunaratne, 2023). In the context of mathematics education, efforts to enhance the quality of learning have become a primary focus for researchers and education practitioners (Tanikawa, et al., 2024; Tarso et al., 2024). One commonly employed strategy to ensure effective learning is the development of teaching materials tailored to meet students' needs (Setiawan et al., 2024). The development process of these materials requires not only careful planning but also a structured and systematic approach. One widely used development model is the ADDIE model, which consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). This model has proven to provide a comprehensive framework for designing teaching materials, particularly in mathematics education.

Mathematics, as one of the core subjects, is often perceived as challenging by students (Caesaria et al., 2024). These difficulties are often attributed to a lack of contextual teaching approaches and the absence of effective teaching aids. To address these challenges, teaching materials based on the ADDIE model enable educators to develop learning materials that are more relevant, engaging, and aligned with students' needs. Research on ADDIE-based teaching materials in mathematics has demonstrated positive outcomes, both in improving students' learning achievements and in facilitating interactive and problem-

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based learning (Siswanto et al., 2024). Thus, understanding global research trends related to the ADDIE model, especially in the context of mathematics teaching materials, becomes crucial.

Global research trends indicate that the ADDIE model has not only been applied in one country but has also been adapted to various educational contexts worldwide. For instance, research in developed countries tends to emphasize the integration of technology into ADDIE-based teaching materials, such as the development of e-learning, educational software, or mathematics applications. Meanwhile, in developing countries, research often focuses on adapting teaching materials to overcome resource limitations and enhance student engagement in learning (Alghiffari, & Setiawan, 2024). By understanding these trends, educators can gain insights into how the ADDIE model can be optimized in both local and global contexts.

Moreover, the ADDIE model is considered relevant in mathematics education because it accommodates various pedagogical approaches, such as problem-based learning, project-based learning, and contextual approaches (Spatioti et al., 2022). This provides opportunities for educators to integrate innovative methods into mathematics instruction. During the analysis phase, teachers can identify students' learning gaps; in the design and development phases, they can create suitable teaching materials; while in the implementation and evaluation phases, they can assess the effectiveness of these materials (Hatmoko et al., 2024; Suryaningsih et al., 2023). This approach positions the ADDIE model not only as a tool for development but also as a strategy for holistically improving the quality of learning.

However, despite the advantages of the ADDIE model highlighted in numerous studies, challenges remain in its application, particularly in the field of education. These challenges include teachers' limited time to go through all the ADDIE stages comprehensively, the lack of professional training on the use of this model, and insufficient resources to support the development of innovative teaching materials (Siswanto & Andriyani, 2024). Therefore, further exploration is needed to determine how the ADDIE model can be implemented efficiently and effectively, especially in resource-constrained environments.

Research on global trends in the ADDIE model within education is essential to identify patterns, successes, and challenges in applying this model across different contexts. Additionally, such research can provide recommendations for educators, policymakers, and researchers in developing better learning strategies (Putri et al., 2024). By understanding global research trends, educators can be more confident in adopting the ADDIE model and ensuring that the teaching materials developed are truly relevant to students' needs and curriculum demands (Suryani et al., 2024; Syah et al., 2024). Ultimately, this research aims to contribute to the literature on mathematics education and enrich understanding of how the ADDIE model can be used as a strategic tool in education. By exploring global research trends, it is hoped that this study can serve as a valuable reference for educators, researchers, and policymakers in improving the quality of mathematics education at both local and international levels.

Literatur Review

ADDIE Development Model

The ADDIE development model (Analysis, Design, Development, Implementation, Evaluation) is a systematic framework widely used in instructional material development (Putri et al., 2024). The first stage, analysis, aims to identify learning needs, such as student characteristics, learning objectives, and relevant content. The design stage focuses on planning learning strategies, selecting media, and creating a blueprint for instructional materials (Pisriwati et al., 2024). During the development stage, instructional materials are designed based on the pre-established blueprint. Following this, the materials are implemented in the classroom and concluded with an evaluation to measure their effectiveness. The ADDIE model offers flexibility as it can be applied in various contexts, including technology-based learning and traditional learning environments.

The strength of the ADDIE model lies in its systematic and iterative approach (Branch, 2009). Each stage can be evaluated and adjusted to ensure the effectiveness of the developed instructional materials. For instance, in mathematics education, teachers can use ADDIE to create technology-based instructional tools such as interactive modules or learning applications. However, one major challenge in implementing the ADDIE model is the relatively lengthy time required to complete all stages. Thus, it is essential for educators to receive adequate training to optimally utilize this model (Buczynski et al., 2021).

PRISMA Flow Diagram

The PRISMA flow diagram (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) is a tool used to report the literature selection process in systematic review research (Page et al., 2021). This diagram assists researchers in documenting the number of articles identified, screened, and selected for further analysis. PRISMA consists of four main stages: identification, screening, eligibility, and inclusion. In the identification stage, researchers search for articles from various sources, such as

online databases or gray literature. Screening is conducted to remove duplicate articles and those not relevant based on inclusion criteria. The PRISMA diagram enhances transparency and accountability in the literature selection process (Alam et al., 2023).

The use of the PRISMA flow diagram is crucial in literature review research as it ensures that the entire selection process is accountable (Alghiffari et al., 2024). By including this diagram, researchers can visually demonstrate how data was obtained and provide reasons for excluding certain articles. Furthermore, PRISMA helps readers understand the quality and scope of the literature used. For example, in research on mathematics instructional materials, the PRISMA diagram can be utilized to identify research trends and gaps from relevant articles. This approach strengthens the validity of the study and ensures that the conclusions drawn are based on credible data

2. METHODS

This study used the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure systematic literature selection through the stages of identification, screening, eligibility, and inclusion, with a PRISMA flow diagram highlighting the number of articles selected and excluded and emphasizing the quantitative aspects of the study (Alghiffari et al., 2024). In addition, this study analyzed the number of publications each year, the relevance to mathematics teaching tools, journal names, and network visualization for co-occurrence. The PRISMA flow in this study can be seen in the following figure.

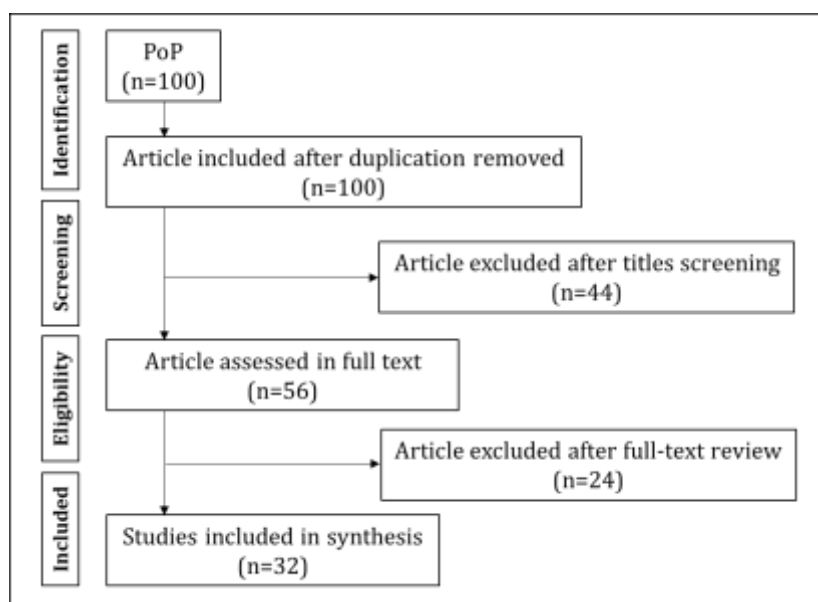


Figure 1. PRISMA flowchart

The data collection process was carried out by selecting articles from various databases in an academic search. Selection criteria were applied through filters and searches using certain keywords with advanced search features on certain database sites. Several acceptance and rejection criteria were set, as shown in Table 1. Acceptance criteria included articles published between 2014-2024. Rejected articles included articles published before 2014 and articles that were not part of a journal or proceedings. Selected articles must be related to the implementation of the ADDIE development model. Articles were defined through keyword searches ($n = 100$). Articles that were excluded ($n = 44$). Articles that passed the screening were 56, and after going through the final selection, the number remained 56. Of these, 32 articles were used for research analysis, while articles without full text or titles that were not relevant to the research were excluded ($n = 24$).

3. RESULT AND DISCUSSION

Results

The results of this study are related to the analysis of 32 articles to answer the research questions after going through a review process using the PRISMA method. The selected articles were analyzed systematically using thematic analysis, with the initial step of presenting and comparing the 32 selected articles as seen in the following table.

Table 1. 32 Selected Articles

Author Citation
Adeoye et al. (2024), Almelhi (2021), Alnajdi (2018), Baharuddin (2018), Balanyk (2017), Budoya et al. (2019), Cheung (2016), Constancio et al. (2018), Djojo et al. (2021), Ghani & Daud (2018), Handrianto et al. (2021), Ismail et al. (2018), Iswati (2019), Jais et al. (2022), Kim et al. (2020), Koc (2020), Latif & Nor (2020), Li & Abidin (2024), Mariam & NAM (2019), Martatiana et al. (2023), Muruganantham (2015), Nadiyah & Faaizah (2015), Najuah et al. (2021), Sahaat et al. (2020), Spatioti et al. (2022), Stapa & Mohammad (2019), Trust & Pektas (2018), Tu et al. (2021), Widyastuti (2019), Woo (2018), Yeh & Tseng (2019) and Zou et al. (2024)

The first research question relates to the distribution of research on the ADDIE development model by year of publication. Overall, Figure 1 depicts the distribution of publication years in the use of the ADDIE development model in education.

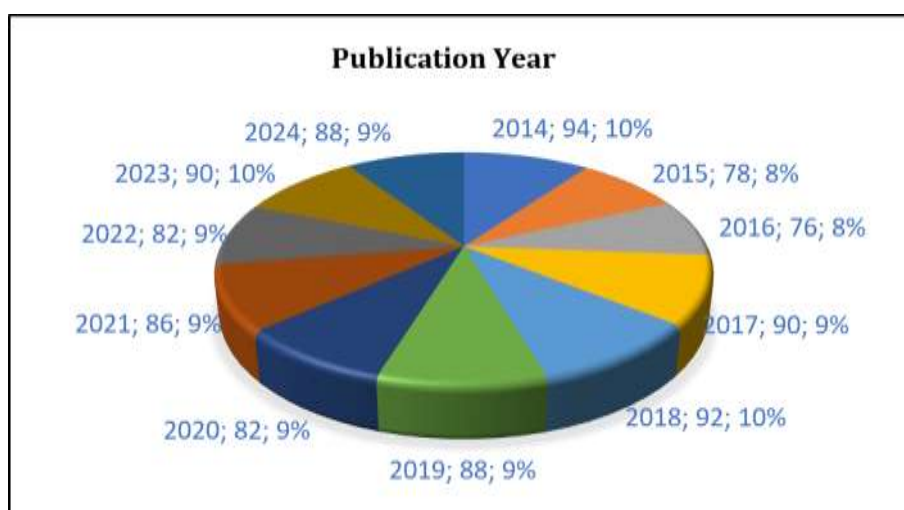


Figure 2. Publication Year

Based on the figure above, in 2014, there was a total of 1. The number increased to 2 in 2015, but dropped back to 1 in 2016 and remained stable in 2017. In 2018, there was a significant spike with a total of 7. However, the number began to decline to 6 in 2019 and continued to decline to 3 in 2020. In 2021, the number increased to 5, but dropped back to 2 in 2022. In 2023, the number only reached 1, but increased slightly to 3 in 2024.

Discussion

The results of this study provide an overview of the trends in the use of the ADDIE development model in education, based on an analysis of 32 articles selected using the PRISMA method. The study indicates that the ADDIE model remains a relevant and widely used framework for developing teaching materials. A systematic analysis of these articles shows that the ADDIE model is applied not only to ensure effective learning but also to design innovative learning tools that cater to students' needs in various contexts. The spike in publications in 2018, with a total of 7 articles, indicates a significant interest in this model, likely related to the need for more structured and technology-based learning tools.

The ADDIE model consists of five stages: Analyze, Design, Develop, Implement, and Evaluate. In the context of mathematics learning, this approach can assist teachers in designing teaching materials that are more responsive to students' needs. The analysis phase allows teachers to understand students' difficulties in grasping certain topics, such as geometry or trigonometry. For example, students struggling to understand abstract concepts can benefit from visual or manipulative-based teaching tools. By understanding these needs, teachers can design more relevant and contextual teaching materials.

The fluctuating publication distribution from year to year, as seen in Figure 1, reflects the challenges in maintaining continuous research on the ADDIE model. However, this also reflects the dynamics of educational research, which continues to evolve. The surge in 2018 may indicate a growing focus on 21st-century learning, which emphasizes critical and collaborative skills, facilitated by teaching materials designed using the ADDIE model. For example, technology-based mathematics teaching tools,

such as e-modules or interactive learning applications, can be developed through the ADDIE approach to support students' needs in the digital era.

Mathematics teaching materials designed with the ADDIE model hold great potential in enhancing students' understanding of the subject matter. For instance, in geometry learning, simulation-based or software tools can help students visualize spatial and dimensional concepts. Additionally, context-based teaching materials, such as those integrating ethnomathematics elements, can also be developed using this model to help students relate mathematics learning to their everyday lives or local culture.

The implementation step in the ADDIE model allows teachers to test teaching materials in the classroom, enabling them to evaluate how effective these materials are in improving student learning outcomes. In the context of mathematics learning, evaluating teaching materials not only focuses on understanding concepts but also on enhancing critical thinking and problem-solving skills (Andriyani, 2024; Siswanto & Hanama, 2024). Teachers can use various methods, such as diagnostic tests or observations, to assess the success of these teaching materials.

Ongoing research on the ADDIE model demonstrates that this framework remains relevant despite changes in teaching approaches and the technology used. For example, in recent years, the development of technology-based teaching materials has become increasingly important, especially during the COVID-19 pandemic. The ADDIE model can be used to develop digital teaching materials, such as learning videos, online learning platforms, or educational games, tailored to students' needs during remote learning.

Considering the findings of this study, it is essential for educators and researchers to continue developing innovative teaching materials using the ADDIE model. In mathematics learning, this can include the development of technology-based teaching tools that support collaborative, project-based, or context-based learning. Thus, the ADDIE model can serve as a fundamental foundation for improving the quality of mathematics education, both in terms of effectiveness and its relevance to the future needs of students.

4. CONCLUSION

Based on the research results, analysis of 32 articles using the PRISMA method shows that the ADDIE development model remains relevant and widely used in the development of teaching materials in various educational contexts. This model, which consists of five stages (Analyze, Design, Develop, Implement, and Evaluate), has proven effective in designing teaching materials that are responsive to student needs, such as e-modules, interactive applications, and other technology-based learning tools. The fluctuating distribution of research, with a significant spike in 2018, reflects the increasing need for structured and innovative teaching materials to face the challenges of 21st-century learning. In mathematics learning, visual, manipulative, and contextual teaching materials developed through the ADDIE model not only help students understand abstract concepts but also encourage critical thinking, problem-solving, and collaboration skills. Therefore, the development of ADDIE-based teaching materials needs to continue to be carried out to produce learning that is relevant to the needs of students in the digital era and to improve the overall quality of education.

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