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Development of Discovery Learning–Based Interactive Infographic Media on Renewable Energy Materials for Elementary School Students

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Abstract: The limitations of visual learning media that are appropriate for the characteristics of elementary school students have an impact on the low level of understanding of abstract science material, such as renewable energy. In the context of the need for a learning approach that supports active engagement and visualization, this study aims to develop interactive infographic media based on Discovery Learning for renewable energy materials for sixth-grade elementary school students. This study employs the Research and Development (R&D) method using the ADDIE model, which consists of the analysis, design, development, implementation, and evaluation stages. Validation was conducted by experts in media, language, and content, while practicality and effectiveness were tested through limited trials and field tests involving teachers and students at SD Negeri 1 Pagar Kaya. The results of the study indicate that the developed media meet the criteria for high validity (average >85%), high practicality (average >90%), and effectiveness (N-Gain = 0.72) in enhancing students' understanding. The interactive infographic media developed facilitates the discovery-based learning process in a visual and engaging manner, encouraging students to actively explore concepts related to renewable energy. This study confirms that the integration of interactive visual design and the Discovery Learning approach can be an effective strategy for developing digitally based science learning media at the elementary level.

Keywords: Addie; Discovery learning; Interactive infographics; Learning media; Renewable energy

Introduction

Learning is a planned activity that aims to develop students' knowledge, skills, and attitudes through interactions between teachers, students, and media within a learning enviroment (Azani et al., 2024). As formal educational institutions, schools play a significant role in shaping students' character and competence, a process greatly influenced by the implemented curriculum and learning strategies (Pardosi, 2024). The Merdeka Curriculum emphasizes the importance of context-based learning and hands-on experience, enabling students to develop a meaningful understanding of scientific concepts (Kartika, 2024). However, it remains challenging to deliver abstract material, such as the concepts of energy and renewable energy, to elementary school students (Akinsemolu & Onyeaka, 2025). This is due to the cognitive development characteristics of elementary school students, who are at the concrete operational stage according to Piaget, as cited in (Silva et al., 2024). At this stage, students require visual aids and real-life experiences to grasp abstract concepts (Marinda, 2020). One possible solution to address these limitations is the use of interactive learning media, which has the potential to enhance student comprehension. Interactive infographics, for instance, have gained significant popularity as a means to convey complex information (Jaleniauskiene &

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Kasperiuniene, 2023). Interactive infographics present information through a combination of visuals, text, and interactivity in order to increase attention, retention, and understanding of concepts (Nkosinkulu, 2024; Doukianou et al., 2021).

In the context of science learning, the use of visual media has been found to be beneficial in assisting students in constructing the meaning of scientific concepts (Wahyu, 2024). In addition to media selection, learning approaches play an important role in achieving learning objectives. One approach is the Discovery Learning method, which involves students actively discovering concepts through exploration, observation, and experimentation (Ilmiati, 2024). Studies have shown that this approach improves students' critical thinking skills and conceptual understanding (Van Der Zanden et al., 2020). Integrating interactive media with the Discovery Learning approach creates a fun, challenging, and meaningful learning experience for elementary school students (Anisa et al., 2021). However, based on the results of observations and preliminary studies, it was found that interactive infographics using the Discovery Learning approach are rarely developed or used for teaching science, especially renewable energy, in elementary schools (Afianah & Hasanah, 2021). This material is highly relevant to pressing global issues, such as climate change and the energy crisis, that require early awareness and understanding (Merritt et al., 2024).

Therefore, developing visual and interactive learning media is urgent for supporting contextual and future-oriented learning (Rukoyah & Bektiningsih, 2024). The goal of this study is to develop interactive infographic media based on Discovery Learning that is feasible, practical, and effective for teaching renewable energy concepts to elementary school students. The development process used the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, which is commonly employed in educational research (Li & Cheong, 2023). The resulting product is expected to optimize the learning process by providing students with attractive visualizations and learning activities that stimulate concept discovery. Thus, this research addresses the challenges of teaching renewable energy to elementary school students and strengthens contributions to learning media innovations relevant to technological developments and 21st-century learning needs (Gayatri et al., 2025). The development adds to the collection of references for interactive learning media that support the implementation of the Merdeka Curriculum and experience-based learning for students.

Method

This research project is a development study that aims to produce interactive infographic learning media based on discovery learning for elementary school students on the topic of renewable energy. This research uses the ADDIE model, consisting of five stages: analysis, design, development, implementation, and evaluation (Spatioti et al., 2022). The model is selected based on its systematic and flexible nature for effectively developing technology-based learning products (Jemmy Pakaja et al., 2024). The ADDIE model was chosen because it provides a systematic and flexible framework for designing and evaluating technology based learning products. Each stage of the model supports the development of effective, efficient, and engaging media for science learning in primary school.

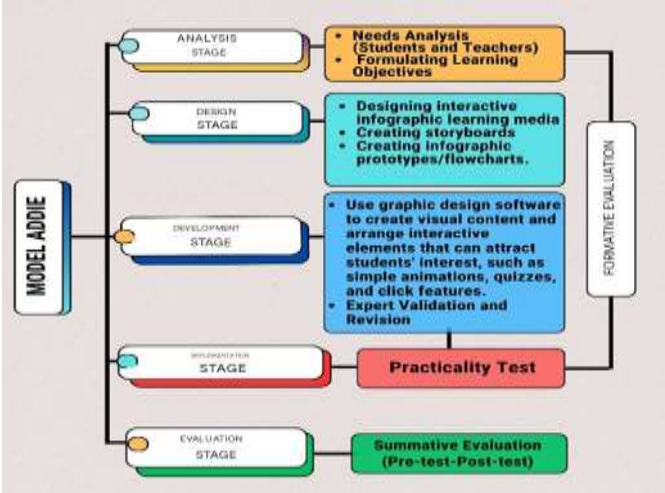

Figure 1. Development process

Research Procedure

This research was conducted through five stages based on the ADDIE development model: Analysis, Design, Development, Implementation, and Evaluation. During the analysis stage, the researchers identified students' and teachers' needs related to learning about renewable energy, including characteristics of difficult-to-understand material and elementary school students' learning styles. These results formed the basis for the design stage, in which interactive infographic media were designed according to the principles of visual pedagogy, and learning storyboards were compiled that aligned with the Discovery Learning approach. The next stage was development, during which interactive infographics were created using relevant digital software. During the development stage, the interactive infographic media were designed using Canva as the primary platform for creating visual elements. Canva was selected due to its user-friendly interface, design flexibility, and the availability of educational icons, illustrations, and templates suited to the characteristics of elementary school students. Each infographic was crafted based on child-friendly universal design principles, including the use of bright colors, intuitive icons, child-appropriate fonts, and consistent visual structure.

Once the visual design was completed, the media was integrated into a digital application using Smart Apps Creator (SAC). This application allows developers to embed various interactive features such as navigation

buttons, audio narration, multiple-choice quizzes, transition animations, and drag-and-drop elements. These features were purposefully designed to support the stages of Discovery Learning, enabling students to explore and elaborate on renewable energy concepts independently. The final product was packaged in .apk format (Android application) and was also made compatible with Windows-based desktop devices. Additionally, the media were accessible offline, which supports learning in areas with limited internet connectivity. Voice narration was included to assist students who are not yet fluent readers, and all content was adapted to align with the cognitive development of 11–12-years old students, based on Piaget's theory.

Results and Discussion

The integration of Canva and Smart Apps Creator in the development of this interactive media represents an innovative approach that addresses the need for visual, participatory, and contextual learning in the Merdeka Belajar (Freedom to Learn) era. In addition to offering an engaging learning experience, this media also facilitates more active and independent discovery-based learning. The research design and method are clearly defined.

Figure 2. Interface of the interactive infographic media

Figure 3. Example of an interactive activity within the media

The product was validated by three experts in material, media, and linguistics to ensure the content was accurate, visually appealing, and communicated effectively. After validation and improvement, the research entered the implementation stage, which included one-on-one and small-group trials with sixth-grade students to obtain preliminary data on the media's acceptability and ease of use. The final stage was the evaluation of the practicality and effectiveness of the learning media. Practicality was analyzed based on teacher and student questionnaire results, while effectiveness was assessed based on improvements in student learning outcomes before and after using the media. These stages are sequential and interrelated to produce media products suitable for teaching renewable energy at the elementary school level. This study involved 60 students, who participated in three stages of testing: one-on-one, small group, and field test.

Table 1. Research Subjects

Subject	Quantity	Role
Media Expert	1	Evaluates the feasibility of the media in terms of visual appearance
Content Expert	1	Evaluates the feasibility of the media in terms of content
Language Expert	1	Evaluates the feasibility of the media in terms of language usage
Students	60	Evaluate the practicality and effectiveness of the media

In this study, data were collected using questionnaires. Two types of questionnaires were used: the feasibility evaluation questionnaire and the user response questionnaire. The feasibility evaluation questionnaire assessed whether the developed product met the expected standards. Three groups of experts evaluated this instrument: experts in media, content, and language. The grids for the feasibility assessment instrument are presented below:

Table 2. Media Expert Feasibility Instrument Lattice

Assessment Aspect
Visual Design
Interactivity
Functionality and Technology
Design Consistency and Aesthetics
The Usefulness of the Design for Learning
User Experience

Table 3. Grids of Language Expert Feasibility Instruments

Assessment Aspect
Word/Sentence Writing
Paragraph Writing
Spacing Usage
Letter and Number Writing

Table 4. Material Expert Feasibility Instrument Lattice

Assessment Aspect
Curriculum
Content/Material
Evaluation
Compliance with Discovery Learning

In addition to the feasibility test questionnaire, this study also used a response questionnaire as a data collection instrument. The response questionnaire aimed to assess the practicality of the product developed in the study. Students completed this instrument after using the designed learning media. The response questionnaire grids used in this study are presented below.

Table 5. Response Questionnaire Grid

Assessment Aspect
Ease of Use
Engagement and Motivation
Understanding of the Material
Visual Design and Interactivity
Suitability for Students' Needs

The feasibility and practicality of the learning media were assessed using a quantitative approach involving a questionnaire completed by experts in media, materials, and language, as well as students. The instrument used a five-point Likert scale to collect data on the suitability and ease of use of the developed media. Additionally, N-Gain analysis was employed to evaluate the effectiveness of the media in enhancing student learning outcomes by comparing pre- and post-test scores. This technique measures the level of improvement in students' understanding after they have used the learning media. The success of interactive infographic media based on the Discovery Learning approach for teaching renewable energy to elementary school students was assessed through feasibility and practicality testing. The results showed that the media were in the 'Very Good' category. The quantitative analysis was based on the N-Gain calculation (Isnaniah & Imamuddin, 2020; Kotronoulas et al., 2023). The results of the assessment of the media's feasibility, practicality, and effectiveness are presented in the following table.

Table 6. Likert Scale Rating Levels

Student Response
Very Good
Good
Fair
Poor
Very Poor

Table 7. Criteria for Feasibility Score Assessment

Range (%)	Category
21- 40	Less Feasible
41-60	Fairly Feasible
61- 80	Feasible
81 - 100	Highly Feasible

Table 8. Practical Score Assessment Criteria

Range (%)	Category
0 - 20	Very Impractical
21 - 40	Impractical
41 - 60	Fair
61 - 80	Practical
81 - 100	Highly Practical

Table 9. Recap of Pretest and Posttest Results

Score Interval	Number of Pretests	Number of Posttests	Pretest Percentage (%)	Posttest Percentage (%)	Description
0-59	45	0	95.56	0.0	Very Poor
60-69	0	0	4.44	0.0	Poor
70-79	0	5	0.0	11.11	Fair
80-89	0	16	0.0	35.56	Good

Findings And Discussion

The aim of this research is to develop interactive infographic media based on Discovery Learning for teaching renewable energy to elementary school students. The effectiveness, practicality, and validity of the developed media are evaluated in response to the proposed problem formulation. The following findings are presented based on the test sequence in the ADDIE model, alongside a discussion linking the results to previous research findings.

Validity of Interactive Infographics Media

Media validity was measured through an assessment by three experts, who evaluated the material, media design, and language aspects. The experts conducted their assessments using a four-point Likert scale, and the results were averaged. The validation recapitulation results are shown in the figure 4.

Overall, the interactive infographic meets the criteria for feasibility (>85%). This demonstrates that the product aligns with the curriculum, the visual display aids learning and the language is comprehensible to primary school students.

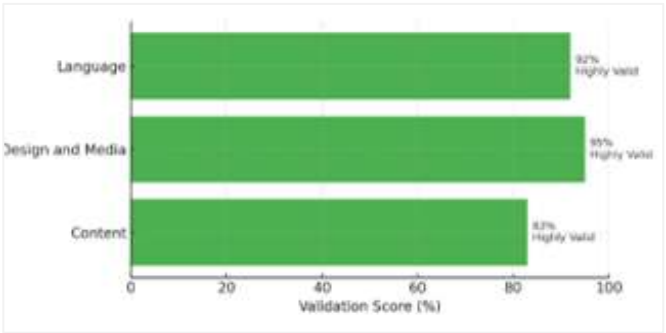

Figure 4. Expert validation

Media Practicality

The practicality of the media was assessed based on student feedback from the one-to-one and small-group

sessions. Figure 5 shows the percentage of student responses across six aspects of practicality, with all aspects scoring above 82%, indicating a high level of satisfaction and usability. These results align with previous research (Fink et al., 2023; Macris et al., 2025), which suggests that interactive visual media can enhance student engagement and effectively convey abstract concepts.

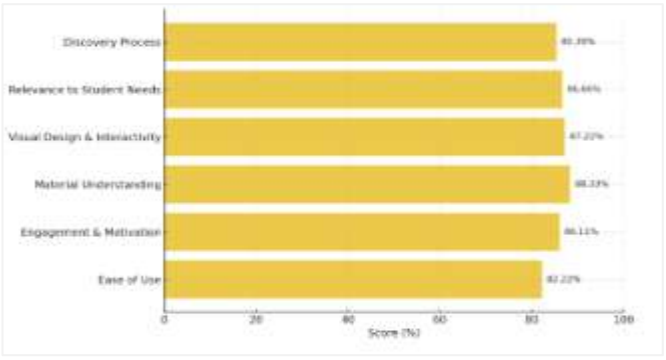

Figure 5. Product practicality

Media Effectiveness on Student Learning Outcomes

The effectiveness of the interactive infographic media was evaluated by comparing students' pretest and posttest scores through a field trial involving 45 sixth grade students. The learning intervention was conducted over the course of three classroom sessions, each lasting approximately 60 minutes, spread across one week. During this period, the media was integrated into science lessons focusing on renewable energy concepts. The structured use of the media over multiple sessions allowed students sufficient time to explore the content, engage with the interactive features, and apply their understanding through the Discovery Learning approach. The repeated exposure and continuity in media usage supported progressive conceptual development rather than surface-level recall. The pretest-posttest comparison showed a significant increase in student learning outcomes, with the average score improving from 37.77 to 84.22 and an N-Gain of 0.72, indicating a high level of effectiveness. This result suggests that even within a short intervention duration, consistent and focused use of well-designed interactive media can produce meaningful improvements in students' understanding of abstract scientific concepts.

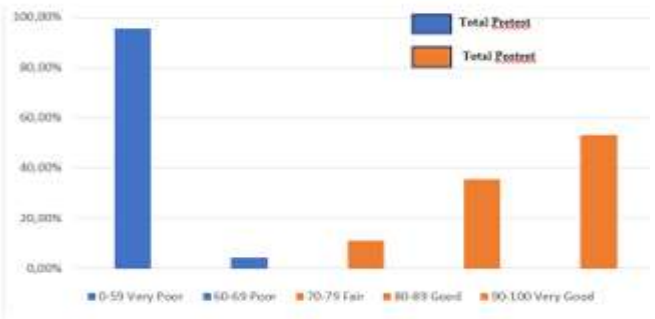

Figure 6. Pretest and posttest results

Interactive infographics have been proven to be an effective way of improving understanding of renewable energy concepts. The informative visuals and exploratory activities offered by the Discovery Learning approach can facilitate active and constructive learning (Ningsih et al., 2025; Marougkas et al., 2023).

Analysis of Learning Gain

To further explore individual learning gains, a distribution analysis of students' N-Gain scores was conducted. Figure 7 shows the categorization of learning gains based on normalized gain scores for each student.

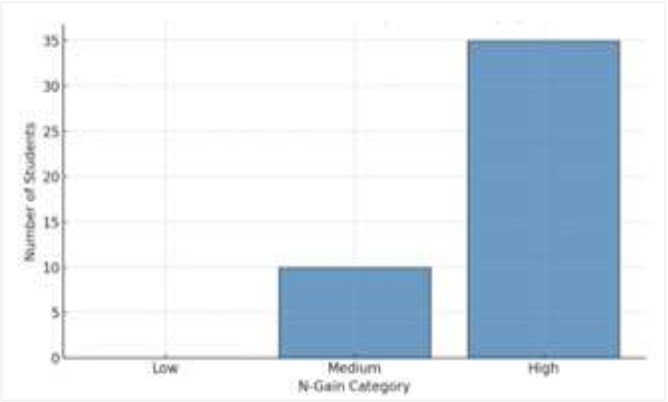

Figure 7. Distribution of student n-gain scores

This pattern confirms that the interactive infographic media not only improved average scores but also benefitted individual learners across ability levels.

Discussion

The results showed that the interactive infographic media based on Discovery Learning met the criteria of being valid, practical, and effective for teaching renewable energy (Saharani & Abadi, 2024; Fitrianawati & Noerazizah, 2025). These results align with the initial research objectives outlined in the introduction: to create learning materials that improve elementary school student's understanding of renewable energy concepts through visual and participatory learning. These results are also consistent with previous research (Asli, 2025; Lestari & Setyasto, 2025). From a scientific perspective, the high media validity (average >85%) suggests that the material, language, and visual design are aligned with the cognitive needs of elementary school students. The involvement of experts in the validation process reinforces this, ensuring that the resulting media is grounded in strong pedagogical and visual aesthetic principles. The structured design, which takes the form of flowcharts and storyboards, is based on visual learning theory and the Discovery Learning approach (Subagja et al., 2023). This design strengthens the cohesion between the content and the information presentation strategy.

The high practicality of the media, as reflected in the responses of teachers and students (>90%), indicates that the media is easy to use, interesting, and pedagogically

relevant. These results align with previous studies Saputri et al. (2025), Pradana (2023) research, which states that interactive media encourages student engagement and focus more effectively than conventional methods. The research also shows that students more easily understand abstract material when it is presented in an interactive, contextual, visual form. These results align with earlier findings Kaplar et al. (2022), Lafifa et al. (2023) research. The effectiveness of the media was demonstrated by a significant increase in post-test scores (N-Gain: 0.72). This finding confirms that discovery-based learning guided by interactive infographics can stimulate critical thinking and conceptual understanding in students. This finding aligns with a previous study Golubnycha (2022), Johnson et al. (2013) that states Discovery Learning encourages students to actively discover knowledge through exploratory learning experiences.

Although the results of this study demonstrate the validity, practicality, and effectiveness of the developed media, the field trial was limited to a single elementary school and conducted within a relatively homogeneous learning context. As such, the generalizability of the findings remains constrained. To strengthen the external validity of the product, future research should include larger and more diverse samples, encompassing schools in urban, rural, and remote areas with varying levels of digital infrastructure. Furthermore, comparative studies across different grade levels and socio-economic backgrounds would provide a broader understanding of the media's adaptability and scalability. Furthermore, it is recommended that future evaluations adopt longitudinal designs to assess knowledge retention over time, as well as to examine the media's influence on students' behavioral engagement, scientific attitudes, and environmental awareness related to renewable energy. Integration with project-based learning (PjBL) or STEAM oriented approaches may further enrich the learning experience and foster deeper conceptual understanding. These recommendations are in line with the findings of Conradty et al. (2020), Atika et al. (2023), and Maričić et al. (2025).

Conclusion

This research project involves the development of interactive infographics on renewable energy materials for elementary school students using the Discovery Learning approach. The effectiveness of these materials was validated using the ADDIE development model. The resulting media meets three main criteria: it is feasible, practical, and effective. Regarding validity, the involvement of experts in evaluating the content, visual design, and language resulted in an average score above 85%, indicating the media's alignment with curriculum needs and learner characteristics. In terms of practicality, teachers declared the media very easy to use, and students found it interesting, with an average response score above 90%. The media's effectiveness is evidenced by a significant increase in student learning outcomes (N-Gain 0.72), indicating that presenting information through interactive, exploratory visualizations successfully facilitates understanding of abstract renewable energy concepts. Further testing with diverse student populations and extended implementation periods is recommended to validate the media's effectiveness in broader educational contexts and ensure its long-term impact on students' conceptual understanding and environmental literacy.

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Author Contributions
Conceptualization; methodology.; validation; formal analysis; investigation; R. M..; resources; data curation; writing—original draft preparation; D. S writing—review and editing.; visualization: M. R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
No conflict interest.

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