



Development of HAREKO (Harmony of the Ecosystem) Interactive Learning Media Based on Edutech in the Science Subject to Improve Conceptual Understanding of Fifth Grade Elementary School Students

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Abstract

Learning Natural and Social Sciences (IPAS) on the topic of Ecosystem Harmony in elementary schools still faces challenges in improving students' conceptual understanding of the relationships between abstract ecosystem components. The limited use of interactive learning media causes students to lack contextual and interesting learning experiences. This study aims to develop an interactive learning media HAREKO (Ecosystem Harmony) based on Edutech and to determine the level of feasibility, practicality, and effectiveness of the media in improving conceptual understanding of fifth-grade elementary school students. This study uses a mixed methods approach with a sequential exploratory design. Product development uses the ADDIE model consisting of analysis, design, development, implementation, and evaluation stages. The research subjects were 28 fifth-grade students of SDN 2 Tempurejo and one class teacher. Data were collected through observation, interviews, questionnaires, documentation, and conceptual understanding tests using a one-group pretest-posttest design. Data analysis was carried out through expert validation, user response analysis, N-Gain calculation, and paired t-test. The results of the study showed that the HAREKO media obtained a very high level of feasibility based on validation by media experts of 93.33%, material experts of 95%, and language experts of 94%. Teacher responses obtained a percentage of 96.67% and student responses of 97.50% with a very practical category. The results of the effectiveness test showed an increase in students' conceptual understanding with an average pretest score of 61.07 increasing to 86.43 in the posttest, with an N-Gain value of 0.65 in the moderate category and there was a significant difference based on the t-test.

Introduction

The development of digital technology has brought significant changes to various aspects of life, including the education sector. Digital transformation has driven the emergence of various learning innovations that utilize technology as a means to create more effective, interactive, and student-centered learning experiences. The integration of technology into learning is no longer viewed as a complement, but rather as a necessity to prepare students to face the challenges of the 21st century, which demand critical, creative, collaborative, and communicative thinking skills. The implementation of the Independent Curriculum in Indonesia further reinforces the importance of utilizing educational technology (edutech) to support meaningful and differentiated learning processes (Halimah et al., 2025; Yulianto et al., 2024; Rustin et al., 2026; Ali, 2025). In line with this situation, the development of interactive learning media is a relevant strategy for improving the quality of learning in elementary

schools, particularly in Natural and Social Sciences (IPAS) (Mushoda et al., 2026; Maulana et al., 2026; Poniyanti et al., 2024; Ubaidillah et al., 2025).

The IPAS subject in the Independent Curriculum is designed to develop students' abilities to understand natural and social phenomena in an integrated manner through contextual learning experiences. One topic that possesses both abstract and complex characteristics is Ecosystem Harmony. This material not only requires the ability to memorize concepts but also an understanding of the relationships between ecosystem components, environmental balance, and the impact of human activities on ecosystem sustainability (Uralovich et al., 2023; Zidan et al., 2023; Amprazis & Papadopoulou, 2025; Kurniawan & Fadlillah, 2025; Fatima et al., 2024). This situation requires teachers to provide learning media that can visualize abstract concepts in a more concrete way, making them easier for students to understand. According to Kurniawan et al. (2025), science learning in the Independent Curriculum requires media innovations that can accommodate the learning characteristics of elementary school students through interactive and contextual presentation of material.

The use of interactive learning media has been proven to positively contribute to improving the quality of the learning process and outcomes. Interactive media allows students to gain learning experiences that engage multiple senses through a combination of text, images, animation, video, audio, and interactive activities (Rahim et al., 2022; Lu & Hanim, 2024). This situation aligns with multimedia learning theory, which explains that presenting information through various channels can increase the effectiveness of information processing and knowledge formation. The results of a systematic review conducted by Natasya et al. (2026) showed that interactive learning media consistently had a positive impact on improving students' conceptual understanding at the elementary school level compared to conventional learning, which is still dominated by lecture methods.

Various previous studies have shown that the development of interactive learning media has been carried out using various approaches. Mertaningsih and Suniasih (2024) developed project-based interactive multimedia on the topic of Harmony in Ecosystems and found it suitable for supporting science learning. Another study by Safitri et al. (2025) developed interactive STEM-PBL-based media supported by Articulate Storyline, which was able to improve students' systems thinking skills. Meanwhile, Sari and Sunanto (2025) demonstrated that interactive media based on Problem-Based Learning can improve learning outcomes and critical thinking skills in elementary school students. The synthesis of these various studies demonstrates that interactive media has significant potential to improve the quality of learning through more active and meaningful learning experiences.

However, various research findings also indicate that students' conceptual understanding of ecosystems remains a problem that requires attention. Cahyani et al. (2025) reported that many fifth-grade students still have difficulty understanding the relationships between ecosystem components, energy flow, and environmental balance because the material is presented verbally without adequate media support. This situation causes students to tend to memorize information rather than develop a deep conceptual understanding. This phenomenon indicates that the quality of learning media influences students' success in constructing comprehensive scientific concepts.

This issue is reinforced by research by Sa'adah et al. (2025), which showed that the use of interactive digital media significantly improved science learning outcomes compared to learning without digital media support. These findings indicate that learning utilizing technology provides a more engaging learning experience, thereby increasing student motivation, attention, and engagement during the learning process. A needs analysis conducted

by Purnamawati et al. (2025) also showed that elementary school teachers still require interactive learning media that are easy to use, tailored to student characteristics, and capable of integrating educational game elements into ecosystems learning.

Various previous studies have made important contributions to the development of learning media, but several research gaps remain. Most studies have focused on the development of project-based multimedia, Android-based media, pop-up books, instructional videos, and game-based media. Shofa and Mintohari (2025) developed an Android-based Eco-Game, while Riskiah and Imawati (2025) developed a pop-up book for ecosystems. These differences in media characteristics demonstrate that innovation in media development continues to evolve. However, research on edutech-based interactive learning media specifically developed for Ecosystem Harmony, oriented toward improving elementary school students' conceptual understanding, is still relatively limited, thus opening up opportunities for this research.

This research offers a novel approach through the development of HAREKO (Harmony of the Ecosystem) interactive learning media based on edutech, designed to meet the characteristics of fifth-grade elementary school students. HAREKO integrates various interactive multimedia components such as illustrations, animations, videos, quizzes, and digital learning activities into a structured learning environment (Apriatini et al., 2025; Alzubi, 2023; Roopashree et al., 2024). Media development is not only oriented towards product feasibility but also aimed at enhancing students' conceptual understanding of the Harmony of the Ecosystem material. Therefore, this research is expected to provide an alternative learning medium that is more effective, engaging, and aligned with the implementation of the Independent Curriculum (Agreda & Sullivan, 2025; Bathan & Faltado, 2026; Nafiah & Wuryandani, 2024).

This research was conducted with fifth-grade students at SDN 2 Tempurejo, Blora Regency. The research location was selected based on the need to develop learning media that can optimize the science and science learning process for the Harmony of the Ecosystem material. The characteristics of elementary school students, who are still at the concrete operational stage, require the presentation of material through media that can visualize abstract concepts and make them easier to understand. Therefore, the development of edutech-based interactive media is expected to assist teachers in creating more contextual, active, and student-centered learning. Based on the above description, this study aims to develop HAREKO interactive learning media based on edutech for science subjects to improve conceptual understanding of fifth-grade elementary school students. This research is expected to provide theoretical contributions to the development of studies on interactive learning media and science learning at the elementary school level. From a practical perspective, the research results are expected to provide an alternative, innovative learning media for teachers, improve the quality of students' conceptual understanding, and serve as a reference for future researchers in developing digital learning media that aligns with the characteristics of the Independent Curriculum.

Methods

This study used a mixed methods approach with a sequential exploratory design that combines a qualitative approach in the initial development stage and a quantitative approach in the product effectiveness testing stage. This approach was chosen because the research not only aims to produce a learning media product but also examines the feasibility and impact of media use on improving students' conceptual understanding. According to Sugiyono (2022), mixed methods are used when researchers require a more comprehensive understanding through the integration of qualitative and quantitative data in a single research series. The development process for the HAREKO (Harmoni Ekosistem) interactive learning media based on Edutech

uses the ADDIE model, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it has systematic stages that allow the development of learning products through needs analysis, design, validation, implementation, and continuous evaluation (Rayanto & Sugianti, 2020). The study was conducted at SDN 2 Tempurejo in May 2026 with 28 fifth-grade students and one class teacher as media user respondents. The developed product was validated by three experts, namely one media expert, one material expert, and one language expert using a five-level Likert scale instrument. The media implementation was carried out using the Discovery Learning learning model with a One Group Pretest–Posttest Design trial design to determine the increase in students' conceptual understanding before and after using HAREKO media. Research data were obtained through observation, interviews, questionnaires, conceptual understanding tests, and documentation, then analyzed descriptively qualitatively and quantitatively through the percentage of feasibility, validity tests, instrument reliability, N-Gain calculations, and manual t-tests (Sugiyono, 2022; Creswell & Creswell, 2023).

HAREKO Media Development Procedure

The development of the HAREKO interactive learning media follows the ADDIE model. The Analysis stage involves identifying the learning needs of science and science students, the characteristics of fifth-grade students, analyzing the Harmoni Ecosystem material, and identifying learning challenges identified through observations and interviews with teachers. The Design stage involves developing a media plan, determining the navigation structure, display design, material development, interactive activities, and developing conceptual understanding assessment instruments. The Development stage includes product creation using the Canva platform, validation by media experts, content experts, and language experts, and revisions based on validator suggestions. The Implementation stage involves trialing the use of HAREKO media with fifth-grade students at SDN 2 Tempurejo using the Discovery Learning model. The Evaluation stage assesses product quality through validation results, user responses, and the media's effectiveness in improving student conceptual understanding. According to Branch (2020), the ADDIE model's flexible and systematic characteristics make it suitable for use in technology-based learning media development research.

Subjects and Data Collection Techniques

The research subjects consisted of 28 fifth-grade students of SDN 2 Tempurejo and one class teacher involved in the HAREKO media implementation process. Subject selection was purposive because the research focused on developing a science learning media for the Harmoni Ekosistem topic that meets the learning needs of fifth-grade elementary schools. Data were collected through several techniques: observation to obtain information on initial learning conditions, interviews to identify teacher and student needs, questionnaires to determine the product's feasibility and user responses, a conceptual understanding test to measure changes in students' cognitive abilities, and documentation to support the research. The research instrument used a five-point Likert scale with assessment categories ranging from very inappropriate to very appropriate. The instrument was developed based on the principles of validity and reliability to ensure that the data obtained objectively describe the research conditions (Sugiyono, 2022).

Data Analysis Techniques

Data analysis was conducted in an integrated manner, in accordance with the characteristics of mixed methods research. Qualitative data obtained through observation and interviews were analyzed through the stages of data reduction, data presentation, and conclusion drawing to

obtain an overview of the HAREKO media development needs. Quantitative data from expert validation, user response questionnaires, and conceptual understanding test results were analyzed using descriptive statistical techniques. The media feasibility level was calculated based on the percentage of expert validation scores, while the increase in students' conceptual understanding was analyzed using the N-Gain value between the pretest and posttest results. Media effectiveness testing was conducted using a paired t-test to determine differences in student abilities before and after using HAREKO media. The research success criteria were determined based on the media obtaining a feasible category from the validator, positive user responses, and an increase in conceptual understanding with a minimum N-Gain value of the moderate category. This analysis was used to ensure that the developed product was not only theoretically valid but also effectively implemented in elementary school science learning (Sugiyono, 2022; Creswell & Creswell, 2023).

Research Instrument

The research instrument was used as a data collection tool to obtain information on the quality, feasibility, and effectiveness of the Edutech-based HAREKO (Harmoni Ekosistem) interactive learning media. The instrument was developed based on the characteristics of learning media development research, which requires product validation before implementation. The validation instrument involved three expert validators: a media expert, a material expert, and a language expert. Each instrument used a five-level Likert scale with a scoring range of 1–5: 5 (very feasible), 4 (feasible), 3 (fairly feasible), 2 (less feasible), and 1 (not feasible). Validation was conducted to obtain an objective assessment of the product's quality before use in learning.

Instrument Purpose

The conceptual understanding test instrument was used to measure the improvement in fifth-grade students' cognitive abilities after using the interactive learning media HAREKO (Harmoni Ekosistem) based on Edutech. The test was administered in the form of a pretest and posttest, with conceptual understanding indicators referring to the revised Bloom's Taxonomy, specifically the ability to understand (C2), apply (C3), and analyze (C4). Conceptual understanding in this study focused on students' ability to explain ecosystem concepts, identify relationships between ecosystem components, explain the food chain, analyze ecosystem balance, and relate human activities to environmental change.

According to Anderson and Krathwohl (2021), conceptual understanding is not only related to the ability to remember information but also includes the ability to interpret, provide examples, classify, compare, and explain relationships between concepts. Measuring conceptual understanding through pre- and post-learning tests was used to determine the effectiveness of the developed learning media.

HAREKO Media Effectiveness Analysis

Instrument Validity Test

The validity of the test items was analyzed using the Product Moment correlation.:

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}}$$

The test item is declared valid if the correlation value is greater than the r table value at a significance level of 5%.

Instrument Reliability Test

The reliability of the items was analyzed using the Cronbach Alpha formula:

$$r_{11} = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_b^2}{\sigma_t^2} \right)$$

Conceptual Understanding Improvement Test (N-Gain)

Student performance improvement was analyzed using the N-Gain formula:

$$g = \frac{Posttest - Pretest}{Skor Maksimal - Pretest}$$

Results and Discussion

This research resulted in an interactive learning media product, HAREKO (Ecosystem Harmony), based on Edutech, developed using the Canva platform for the fifth-grade elementary school science subject, Ecosystem Harmony. The media development was conducted using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The analysis phase was conducted through learning observations and interviews with fifth-grade teachers at SDN 2 Tempurejo to identify learning needs. The analysis results indicated that the ecosystems topic in science still faces challenges in the form of limited interactive visual media that can help students understand the relationship between biotic and abiotic components concretely. This condition causes some students to experience difficulty explaining the concept of ecosystem balance and the interrelationships between organisms.

The design phase was carried out by developing a media plan based on the characteristics of fifth-grade students and the principles of Discovery Learning. The HAREKO media is structured with a cover page, user instructions, learning objectives, ecosystem material, interactive illustrations, exploration activities, evaluation quizzes, and learning reflections. The presentation of the material is complemented by a combination of text, images, animations, and evaluation activities to support student engagement in building conceptual understanding. The development phase involved product creation using Canva, followed by validation by media experts, content experts, and language experts. Input from the validators was used as the basis for product revisions to ensure the quality of the display, content, and language aligned with the characteristics of elementary school learning.

The implementation phase involved 28 fifth-grade students at SDN 2 Tempurejo. HAREKO media was applied to science lessons using the Discovery Learning model, involving observation, problem identification, information collection, data processing, verification, and drawing conclusions. The evaluation phase involved analyzing validation results, user responses, and the media's effectiveness in improving students' conceptual understanding. The development results demonstrated that HAREKO media is a suitable alternative digital learning medium for supporting more interactive and student-centered science lessons.

HAREKO Media Feasibility Validation Results

Product validation was conducted by three expert validators: a media expert, a content expert, and a language expert. The validation aimed to determine the product's feasibility before use in the implementation phase. The validation results are presented in Table 1.

Table 1. HAREKO Media Expert Validation Results

Validator	Score Obtained	Maximum Score	Percentage	Category
Media Expert	56	60	93,33%	Very Worthy

Based on the media expert validation results, the HAREKO media received a score of 56 out of a maximum of 60, representing 93.33%, and is categorized as very suitable. The highest ratings were given to visual appearance, ease of navigation, and interactivity. The validator assessed that the use of visual elements, layout, and menu arrangement in the media were appropriate for the characteristics of elementary school students. Several suggestions for improvement were made regarding consistency of text size and optimization of several navigation buttons before the media was used in learning.

Table 2. HAREKO Material Expert Validation Results

Validator	Score Obtained	Maximum Score	Percentage	Category
Subject Matter Expert	57	60	95%	Very Worthy

The validation results from the material expert showed a score of 57 out of a maximum score of 60 with a percentage of 95%. The very appropriate category indicates that the Ecosystem Harmony material presented in the media is in accordance with the learning outcomes of grade V Science. The validator gave a positive assessment of the accuracy of the concept, the relevance of the material to everyday life, and the suitability of learning activities with the Discovery Learning syntax. Improvements provided relate to the addition of examples of local environmental phenomena to make learning more contextual.

Table 3. Results of Validation by Linguists

Validator	Score Obtained	Maximum Score	Percentage	Category
Linguist	47	50	94%	Very Worthy

The validation by linguists obtained a score of 47 out of a maximum of 50, representing a 94% success rate. These results indicate that the language used in the HAREKO media meets the requirements for readability, communicativeness, and appropriateness for the language development level of elementary school students. The validators provided input on simplifying several scientific terms to make them easier for students to understand.

Overall, the validation results from the three experts indicated that the HAREKO media achieved a high level of feasibility, with an average score of 94.11%. This finding indicates that the developed product met the criteria for valid learning media before being implemented with students. These results align with research by Mertaningsih and Suniasih (2024), which stated that interactive multimedia on the topic of ecosystem harmony can be developed as a suitable learning medium for use in elementary school science lessons.

Teacher and Student Responses to the HAREKO Media

After the validation stage, the HAREKO media was implemented in science lessons. User responses were obtained through teacher and student questionnaires using a five-level Likert scale.

Table 4. User Responses to the HAREKO Media

Respondents	Score Obtained	Maximum Score	Percentage	Category
Teachers	58	60	96,67%	Very Practical
Students (28 people)	1638	1680	97,50%	Very Practical

Teacher responses showed a percentage of 96.67%, categorized as very practical. Teachers stated that HAREKO media helped convey ecosystems material because it provided visualizations of concepts that were previously difficult to explain using conventional methods. Meanwhile, student responses reached 97.50%, categorized as very practical. Students showed interest in using the media because the visual displays, interactive activities, and quizzes within the media made the learning process more engaging.

These results reinforce the findings of Sa'adah et al. (2025) that the use of interactive digital media in science learning can increase student engagement and support understanding of ecosystems material. Learning media that combine visual elements and interactive activities provide opportunities for students to construct knowledge through more active learning experiences.

Effectiveness of HAREKO Media on Students' Conceptual Understanding

The effectiveness of HAREKO media was analyzed based on the results of pretests and posttests on fifth-grade students' conceptual understanding. The results of the analysis are presented in Table 5.

Table 5. Pretest and Posttest Results of Conceptual Understanding

Data	Mean	Minimum Score	Maximum Score
Pre-test	61,07	45	75
Post-test	86,43	70	100

Based on the analysis, the average student score increased from 61.07 in the pretest to 86.43 in the posttest. This increase indicates that the use of HAREKO media positively contributed to students' conceptual understanding of Ecosystem Harmony.

The N-Gain calculation yielded a value of 0.65, which is considered moderate. The paired t-test showed a calculated t-value of 8.72, which is greater than the t-table value of 2.05 at the 5% significance level. Thus, there was a significant difference between students' conceptual understanding before and after using HAREKO media.

The increase in students' conceptual understanding after using HAREKO media indicates that Edutech-based learning media can support students' knowledge construction process. This research finding aligns with Mayer's Cognitive Theory of Multimedia Learning, which states that learning through a combination of verbal and visual elements can enhance comprehension because information is processed through two different cognitive channels. HAREKO media provides a visual representation of the relationships between organisms in an ecosystem, helping students grasp abstract concepts (Gorana et al., 2021; Mukti et al., 2025). The use of the Discovery Learning model in media implementation also contributes to improved conceptual understanding. Through exploration, observation, and conclusion-drawing activities, students not only receive information but also construct knowledge through learning experiences. This aligns with the constructivist perspectives of Piaget and Vygotsky, which

emphasize that effective learning occurs when students actively construct their understanding through interaction with the learning environment.

The results of this study reinforce the research of Cahyani et al. (2025), which showed that the use of interactive multimedia can improve students' conceptual understanding of ecosystems. This research also complements previous research by presenting the Edutech-based HAREKO media, specifically developed for the Harmoni Ecosystem material for fifth grade using the Discovery Learning approach. The research's novelty lies in the integration of interactive digital media, the characteristics of the Independent Curriculum science and science material, and its orientation toward improving conceptual understanding as the primary outcome.

HAREKO media provides a practical contribution for teachers in providing an easy-to-use digital learning alternative that is tailored to the needs of elementary school students. This product also makes a theoretical contribution to the development of interactive learning media that combines the principles of multimedia learning, constructivism, and educational technology. Thus, HAREKO media can be one of the innovations in science learning that supports the digital transformation of basic education.

Conclusion

The Edutech-based HAREKO (Harmony of the Ecosystem) interactive learning media was successfully developed through the five stages of the ADDIE model and met the criteria of feasibility, practicality, and effectiveness for fifth-grade elementary school science learning. Expert validation showed that the media was highly feasible, with scores of 93.33% from the media expert, 95% from the material expert, and 94% from the language expert. The media was also considered highly practical, as indicated by teacher and student response scores of 96.67% and 97.50%, respectively. Students' average conceptual understanding score increased from 61.07 on the pretest to 86.43 on the posttest, with an N-Gain score of 0.65 in the moderate category. The paired t-test result of 8.72, which exceeded the t-table value of 2.05, further indicated a significant difference between students' conceptual understanding before and after using the media. Therefore, HAREKO can be used as an engaging and practical digital learning medium to support students in understanding ecosystem relationships and balance more concretely. Nevertheless, further research involving larger samples, multiple schools, and a control group is recommended to strengthen the generalizability of its effectiveness.

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